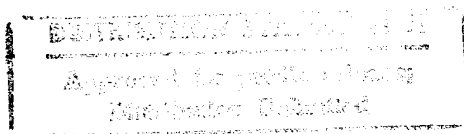




SOIL VAPOR EXTRACTION
PILOT STUDY REPORT
VERSION 3.1
MOTOR POOL AREA
ROCKY MOUNTAIN
ARSENAL



19960719 085

Rocky Mountain Arsenal
Interim Remedial Action
Commerce City, Colorado

Prepared for
U.S. Department of the Army
Corps of Engineers, Omaha District
Omaha, Nebraska
March 1992



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DTIC QUALITY INSPECTED 4

89M114G1

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE 03/00/92		3. REPORT TYPE AND DATES COVERED	
4. TITLE AND SUBTITLE SOIL VAPOR EXTRACTION PILOT STUDY REPORT, MOTOR POOL AREA, ROCKY MOUNTAIN ARSENAL, VERSION 3.1				5. FUNDING NUMBERS	
6. AUTHOR(S)					
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) WOODWARD-CLYDE CONSULTANTS OMAHA, NE				8. PERFORMING ORGANIZATION REPORT NUMBER 92097R02	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) ARMY CORPS OF ENGINEERS, OMAHA DISTRICT OMAHA, NE				10. SPONSORING/MONITORING AGENCY REPORT NUMBER	
11. SUPPLEMENTARY NOTES					
12a. DISTRIBUTION/AVAILABILITY STATEMENT APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED				12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) THIS SOIL VAPOR EXTRACTION PILOT STUDY REPORT FOR THE MOTOR POOL AREA AT THE ROCKY MOUNTAIN ARSENAL IS BEING PREPARED AS PART OF THE INTERIM RESPONSE ACTION. THE RECOMMENDED ACTION AT THE MOTOR POOL AREA WAS TO ADDRESS CONTAMINATED SOIL WITH IN SITU SOIL VAPOR EXTRACTION AND TO ADDRESS CONTAMINATED GROUNDWATER. THIS DOCUMENT PRESENTS THE RESULTS OF THE SOIL VAPOR EXTRACTION PILOT STUDY CONDUCTED BETWEEN JULY AND DECEMBER, 1991 AT THE MOTOR POOL AREA.					
14. SUBJECT TERMS GEOLOGY, SVE, CONTAMINATION, GROUNDWATER, DISPOSAL				15. NUMBER OF PAGES	
				16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT UNCLASSIFIED	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT		

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INTRODUCTION

This Soil Vapor Extraction Pilot Study Report for the Motor Pool Area at the Rocky Mountain Arsenal (RMA) is being prepared as part of the Interim Response Action (IRA) process in accordance with the Federal Facility Agreement and the Technical Program Plan. Determinations concerning the implementation of this IRA have been reached through a consideration of the objectives of Sections 2.3(a), 22.5, and 22.6 of the Federal Facility Agreement and by application of the Decision Flow Chart for Other Contamination Sources IRAs adopted by the Organizations and the State in the June 7, 1989 Subcommittee meeting (WCC 1990).

An alternatives assessment was conducted as part of the IRA process in the fall of 1989. The recommended action at the Motor Pool area was to address contaminated soil with in situ soil vapor extraction and to address contaminated ground water through the use of a pump and treat system in conjunction with a Shell-led IRA which addresses a dibromochloropropane plume emanating from the rail classification yard. This document presents the results of the Soil Vapor Extraction (SVE) Pilot Study conducted between July and December, 1991 at the Motor Pool Area.

An Implementation Document was finalized in February, 1991 which outlined the pilot study plan for soil vapor extraction in the Motor Pool Area. The primary objective of this program was to collect data on the performance of SVE at this site. These data could be used to expand the soil vapor extraction system, if necessary. A secondary objective was to begin removing contaminants from the soil in the area. Section 2.0 of this report outlines the site history, a summary of previous investigations, and the nature and extent of contamination. Section 3.0 presents the technical approach to the pilot system design, including the data collection program and the rationale for evaluating system performance. Section 4.0 presents the test results of the pilot program including an analysis of the data. Section 5.0 presents the conclusions gathered from the pilot program. Appendix A presents the well construction details including soil boring logs and geologic cross sections. Appendix B presents raw analytical results from the SVE sampling program.

SITE BACKGROUND AND INTERIM ACTION INVESTIGATION

This section presents background information on the Motor Pool Area, including site history and the nature and extent of contamination based on previous field investigations. The October 1990 soil investigation and the scope and objectives of the pilot test are also discussed.

2.1 SITE DESCRIPTION

2.1.1 Location

Rocky Mountain Arsenal (RMA) occupies more than 17,000 acres (approximately 27 square miles) in Adams County, directly northeast of metropolitan Denver, Colorado (Figure 2-1). The Motor Pool Area consists of the developed area in the southeastern corner of Section 4 on the RMA. The Motor Pool Area is located near the rail yard, on the west side of the boundary line between Sections 3 and 4, and is approximately 650 feet (east-west) by 2,300 feet (north-south). Structures within the site include 7 above-ground fuel and oil storage tanks, 26 buildings and foundations for 3 buildings that have been removed. The structures consist of administration buildings, motor vehicle storage and maintenance buildings, warehouses, railroad roundhouse and tracks, former agricultural research buildings, fuel storage tanks, fuel station, and a groundwater well pumphouse (Figure 2-2).

2.1.2 History

Prior to 1942, the Motor Pool Area consisted of farm land that was used to produce wheat and corn, or was used as grass land for hay and grazing of cattle. The Motor Pool Area was acquired by the U.S. Army in 1942 as part of RMA. Railroad spurs into the study area, entering across the northwest and southern boundaries, were built during the initial construction of RMA (Ebasco 1989a).

Most of the structures in the study area were built by the Army during the initial construction period of 1942 to 1943. During this period, a sanitary sewer system was constructed that extended north from the Motor Pool and rail yard areas. Portions of the sewer ended in septic tanks and leach fields. In 1945, construction of the sewer was completed with the installation of two pump stations and a pressure pipe that discharged eastward to an outfall into the interceptor line north of the Administration area.

Since the 1940s, the Motor Pool Area has been used by RMA for servicing equipment, vehicles, and railroad cars, as well as for storing fuel, road oil, and flammable liquids.

The roundhouse (Building 631) has been in use since the beginning of operations at RMA in 1942. It has been used for the maintenance of locomotives, railcars, and other heavy equipment. Solvents used to clean parts and surfaces may have been discharged either to a ditch east of the roundhouse or to a septic tank. From 1968 to 1982, the building was used by the U.S. Army reserve units for vehicle maintenance. From 1975 to 1985, it was occasionally used as a repair shop for earth-moving equipment. A small structure for storing cleaning solvents and paint thinners, which were used in Building 631, is attached to Building 631.

Previous Motor Pool Area investigative studies include: a May 1984 Resource Conservation and Recovery Act (RCRA) audit by the Colorado Department of Health (Ebasco 1989a) in the area outside the roundhouse; a 1986 study to identify possible trichloroethylene (TCE) sources in the Motor Pool Area (Ebasco 1988); and a soil gas study conducted in February 1986 to aid in defining the presence of trichloroethylene in the groundwater (Ebasco 1987). The most recent studies include the Contamination Assessment Report (Ebasco 1988); the Western Study Area Report (Ebasco 1989a); a soil gas survey conducted in summer 1989 (WCC 1989), and a pre-design data collection program in October 1990 (WCC 1991a).

2.1.3 Site Geology

The Motor Pool Area is in Section 4 near the western boundary of the RMA. The ground surface in the study area is essentially flat with a nominal slope toward the northwest. There are two stratigraphic units of interest beneath the Motor Pool Area:

the Quaternary Alluvium and the Denver Formation. The alluvial material consists of discontinuous lenses of sand and gravel, interbedded with silt and clay. Gravels and gravelly sands are common at the base of the alluvial section, especially in paleochannels. The alluvial material ranges from about 70 feet to about 100 feet in thickness. Groundwater has been observed at between 60 and 70 feet below ground surface. The thickest alluvium occurs over bedrock lows, and the thinnest over bedrock highs.

The alluvium-bedrock contact is highly irregular due to the extensive erosion that was caused by ancient stream channels, which preceded the deposition of the alluvium. Generally, the bedrock surface slopes to the northwest in the Motor Pool Area; however, where the bedrock surface has been incised by an ancient stream channel, the slope becomes perpendicular to the trend of the paleochannel. A northwest trending paleochannel cuts across the northern boundary of the Motor Pool Area and has approximately 70 feet of relief.

The Denver Formation in the Motor Pool Area is predominantly composed of claystone with interbedded sandstone, siltstone, and lignite layers that vary from about 2 feet to approximately 20 feet thick. Layers of volcanoclastics are also present in the bedrock (Ebasco 1989a).

2.2 NATURE AND EXTENT OF CONTAMINATION

A summary of the nature and extent of contaminants found in the Motor Pool Area is discussed in this section. Information used in this summary was obtained from previous studies, including a soil gas investigation conducted in February 1986 to aid in defining trichloroethylene plumes in the groundwater (Ebasco 1987), a Contamination Assessment Report (Ebasco 1988), the Western Study Area Report (Ebasco 1989a), a soil gas survey conducted in summer 1989 (WCC 1990), and a pre-design data collection program in October 1990 (WCC 1991a). These reports can be referenced for additional details.

2.2.1 Soil Contamination

The soils investigations of the Motor Pool Area have been in three general areas:

- Repair, salvage, and surplus facility (Building 624) and railroad roundhouse (Building 631) areas
- Motor Pool and vehicle maintenance facility (Building 627) area
- Fuel tank storage area

The analytical data were derived from soil samples taken at various depths in the vadose zone. Sampling depths in the boreholes were generally 0 to 1, 4 to 5, 9 to 10, 14 to 15, and 19 to 20 feet. Borings greater than 20 feet in depth were sampled at 10-foot intervals below the 20 foot depth. A summary of the analytical results is shown in Table 2-1.

Indicator levels and ranges were established to assess the significance of organic and metal analytical values. Organic compound indicator levels are set at the certified reporting limit (CRL) for each compound. Metal indicator ranges are set within naturally occurring levels in the alluvial soils at RMA. These indicator ranges are shown in Table 2-1. A more detailed discussion of the selection of the indicator ranges can be found in the Introduction to the Contamination Assessment Reports (ESE 1987).

Trichloroethylene was detected in the area between the roundhouse (Building 631) and Building 624, in a near-surface soil sample taken beneath a man-made drainage ditch. This suggests that, at some time in the past, chlorinated solvents used at these facilities were present in the north-trending ditch.

Concentrations of ICP metals (cadmium, chromium, copper, lead, and zinc) and arsenic above background levels were also found in near-surface soil samples taken from beneath the ditch. This is attributed to the sanding and paint stripping operations performed during equipment maintenance and repair (Final Contaminant Assessment Report, Ebasco, July 1988).

Methylene chloride, trichloropropene, and aldrin were present in soil samples taken near the roundhouse (Table 2-1).

At Building 627, tetrachloroethylene was detected between 18 and 30 feet below grade beneath the same north trending ditch that passes between Building 624 and the roundhouse. These detections may suggest infiltration from the upgradient discharges at the roundhouse and Building 624.

Dibromochloropropane, toluene, and benzothiazole were found in near-surface soil samples taken downgradient from a drainage pipe exiting the south side of Building 627. The drain pipe discharged hot water and detergent in the mid-1960s and diluted wastes from the wash bay since 1951 (Ebasco 1989a).

Methylnaphthalene, pyrene, and fluoranthene were detected in near-surface soil samples taken in the north trending ditch west of Buildings 624 and 627. These analytes are attributed to leaching from railroad ties that had been treated with wood preservatives (Ebasco 1989a).

The fuel tank storage area is located west of Building 627 and consists of seven above-ground tanks. Soil samples from the area showed the following analytes to be present in the near-surface soils (concentrations are summarized in Table 2-1):

- Methylcyclohexane
- Benzene
- Ethylbenzene
- m-Xylene
- Toluene
- Methylnaphthalene

Lead and zinc occurred in surface soils at concentrations slightly exceeding their indicator ranges.

2.2.2 Previous Soil Gas Surveys

Three soil gas investigations have been conducted in the Motor Pool Area to locate organic contaminants. The first soil gas program was conducted in early 1986 (Ebasco 1987) when groundwater sampling had initially detected trichloroethylene near the roundhouse and Building 624. The trichloroethylene soil gas data showed a trichloroethylene soil vapor plume extending northwest from the Motor Pool Area. Another 1986 soil gas program used static samplers over a 1-month period. This study confirmed previous study results (Ebasco 1987).

The most recent soil gas investigation of the Motor Pool Area was conducted in July 1989. Eighty soil gas samples and 6 soil samples were collected in the study area. Sampling depths were 5, 10, 15, and 20 feet below grade, with a standard sampling depth of 5 feet. Sampling results are shown in Figure 2-3.

The volatile organic compounds that were analyzed for at each of the sampling locations included:

- Trichloroethylene (TCE)
- Trans 1,2 Dichloroethylene
- Cis 1,2 Dichloroethylene
- 1,1 Dichloroethylene
- Benzene
- Toluene
- Ethyl benzene
- o, m, p-Xylene

Measured concentrations of TCE in soil gas ranged from the detection limit ($0.01 \mu\text{g/l}$) to about $600 \mu\text{g/l}$, with concentrations of TCE typically greater than $200 \mu\text{g/l}$ in the soil gas between Buildings 624 and 625. Figures 2-3 and 2-4 show the results of the grid sampling conducted in 1989. Additional samples taken in the immediate vicinity of building 624 are presented in tabular form in the field investigation report (WCC 1989).

Evidence seems to indicate that the origin of this TCE contamination is a 3-inch diameter floor drain, shown on 1942 plumbing plans of Building 624, that leads to an outside ditch located between Buildings 624 and 625. TCE was used as a degreasing agent in Building 624.

2.2.3 Groundwater Contamination

Groundwater in the Motor Pool area is 60 to 65 feet below the ground surface (Ebasco 1989a). During the soil gas survey conducted in 1986 at the Motor Pool Area, high TCE concentrations were detected near Buildings 624 and 631 (Ebasco 1987). Groundwater samples from the nearby alluvial wells detected TCE. From these data, the trichloroethylene alluvial groundwater plume is interpreted to originate in the Motor Pool Area and extend to the north-northwest (Figure 2-5). None of the Denver Formation wells in the western study area detected TCE. This finding suggests that the plume is confined in the upper portion of the unconfined aquifer at this site. Refer to the Remedial Investigation Final Report (Ebasco 1989a) for a detailed discussion on the groundwater contamination originating from the Motor Pool Area.

2.3 OCTOBER 1990 SOIL INVESTIGATION

Previous soil investigations at the Motor Pool Area have detected TCE in the soil (Table 2-1). Soil gas surveys in the area have found TCE in soil gas (Figure 2-3). Groundwater investigations have consistently detected elevated levels of TCE in groundwater in the Motor Pool Area (Ebasco 1989a). However, those investigations did not provide the information necessary to design a soil vapor extraction system. Therefore, a focused soil investigation was performed at the Motor Pool Area in October 1990.

The objective of this study was to further characterize the lateral and vertical extent of volatile halogenated organics (VHOs) in soil immediately to the west of Buildings 624 and 625, for purposes of collecting baseline information for the SVE system evaluation. A total of five borings were drilled and sampled at five-foot intervals between ground surface and groundwater. The samples were analyzed for VHOs. The boring locations (Figure 2-6) were selected to characterize the apparent plume observed during the 1989 soil gas survey (Figure 2-4).

Carbon-tetrachloride (CCl_4) was the only target analyte detected in the soil samples collected. The sample taken from boring COEMPA0005 from the 18 to 19 foot interval indicated CCl_4 at a concentration of $0.592 \mu\text{g/g}$. The duplicate sample collected from the 17 to 18 foot interval reported CCl_4 as less than (LT) the certified reporting limit indicating the possibility the detection of this compound was due to a lab contaminant. All other samples were reported as LT for all the VHO target analytes.

Two of the borings (COEMPA0001 and COEMPA0002) were completed as soil gas extraction wells (VES-1 and VES-2, respectively). Well construction details can be found in the Implementation Document. These wells were used to conduct an initial air permeability test to establish a relationship between soil gas flow rate and vacuum applied at the well heads. This information, along with the analytical data from the soil investigation, were used to design the pilot system.

2.4 SCOPE OF PILOT PROGRAM

The five-month pilot program described in Section 3.0 focused on applying Soil Vapor Extraction to a volume of soil which has been shown to contain elevated levels of TCE in the soil gas. The soil vapor extraction wells used for the pilot program (VES-3 and VES-4) are located near the northwest corner of Building 624, approximately corresponding to the highest concentrations of TCE in soil gas detected in the 1989 soil gas survey. The soil to be addressed during the pilot test extends from the surface to groundwater, approximately 63 feet below ground surface.

The pilot program collected engineering data to confirm estimates of flow rate for the extraction wells and the radius of influence from each well. Soil permeability data was obtained when extracting from both wells to confirm the preliminary results gathered in a previous one-day study. Results of soil gas analyses were used with these data to estimate the quantitative effectiveness of vapor extraction at varying depths at this site.

TABLE 2-1

SUMMARY OF SOIL SAMPLE ANALYTICAL RESULTS
MOTOR POOL AREA

Analytical Groups and Analytes Detected	Frequency of Detections ¹	Range ($\mu\text{g/g}$)	CRL Range ($\mu\text{g/g}$) ²	Indicator Range ($\mu\text{g/l}$)
<u>Organochlorine Pesticides</u>				
Aldrin	2/163	0.9-3	0.3	
Arsenic	16/152	2.6-27	2.5-5	CRL-10
Mercury	14/152	0.057-0.38	0.050-0.060	CRL-0.1
<u>ICP Metals</u>				
Cadmium	13/152	1.4-30	0.66-0.74	1-2
Chromium	62/152	6.5-490	5.2-6.5	25-40
Copper	100/152	5.7-220	4.7-4.9	20-35
Lead	37/152	9.8-2000	8.4-13	25-40
Zinc	146/152	11-2300	8.7-9.5	60-80
DBCP	1/177	0.01	0.0050	
<u>Polynuclear Aromatic Hydrocarbons</u>				
Fluoranthene *	5/163	1-30	0.3*	
Pyrene*	6/163	0.5-20	0.3*	
Methyl naphthalene*	8/163	4-200	0.3*	

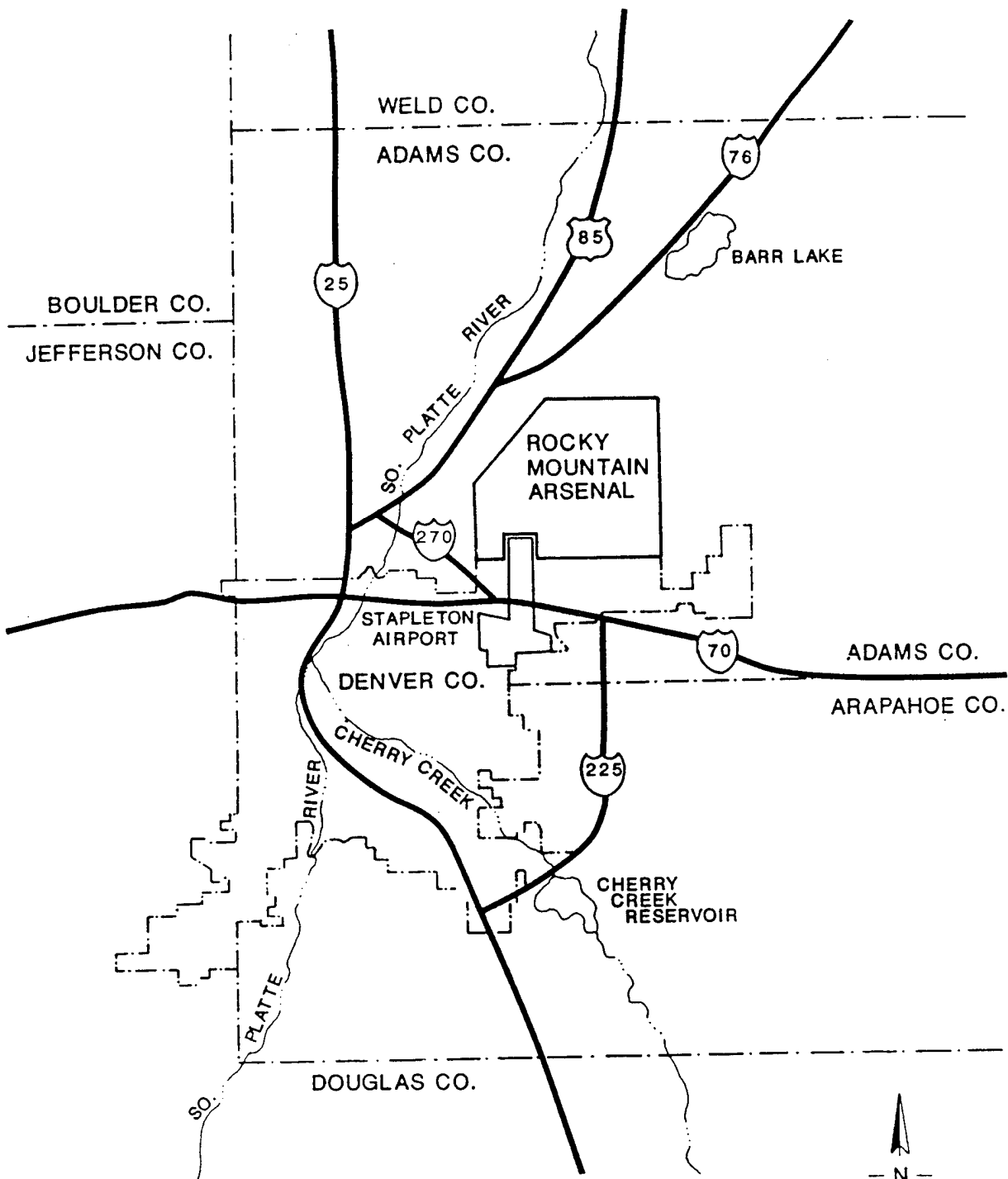
TABLE 2-1
(Continued)

Analytical Groups and Analytes Detected	Frequency of Detections ¹	Range (ug/g)	CRL Range (ug/g) ²	Indicator Range (ug/l)
<u>Volatile Halogenated Organics</u>				
Tetrachloroethylene	3/135	0.4-1	0.3	
Trichloroethylene	1/135	2	0.3-0.5	
Trichloropropene*	1/135	0.2	0.3*	
<u>Methylene Chloride</u>	1/135	3	0.7-2	
<u>Volatile Hydrocarbons</u>				
4-Hydroxy-4-methyl-2-pentanone*	1/135	4	0.3*	
Methylcyclohexane*	2/135	2-10	0.3*	
<u>Volatile Aromatic Organics</u>				
Ethylbenzene	1/135	4	0.3-0.4	
m-Xylene	1/135	2	0.7-0.8	
Toluene	2/135	2-4	0.3	
<u>Organosulfur Compounds</u>				
Benzothiazole	1/163	0.3	0.3*	

TABLE 2-1
(Concluded)

- $\mu\text{g/g}$
- Micrograms per gram
 - Fraction represents the total number of samples with detections of an analyte in relation to the number of analyses conducted on all samples. This value does not include multiple detections of a specific analyte in the same sample, which occasionally has occurred when more than one analytical method has been used. Total number of borings, 36; total number of samples, 165.
 - ² - Certified Reporting Limit (CRL) or detection limit which varies among laboratories conducting analyses.
 - * - There is no CRL for tentatively identified compounds. The value shown is a detection unit based on 10% of the internal standard for the method used. The number of detections is given, but the number of samples is not.

SOURCE: Ebasco, May 1989



Job No. : 22765-4
Prepared by : R.E.S.
Date : 3/26/92

ROCKY MOUNTAIN ARSENAL LOCATION MAP

Figure 2-1



SECTION 3

FOUNDATION

FOUNDATION,

FOUNDATION

LEGEND

- 632 BUILDINGS
- 628A ABOVE GROUND STORAGE TANKS

**SALVAGE
YARD**

FOUNDATION

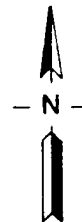
FOUNDATION

KEY MAP, RMA

				23	24
			27	26	25
		33	34	35	36
	4	3	2	1	6
9			11	12	7
					8

MOTOR AREA POOL

RAIL CLASSIFICATION YARD



A horizontal scale bar with tick marks at 0, 250, 500, and 1000 feet. The text "SCALE IN FEET" is centered below the bar.

SOURCE: EBASCO, MOTOR POOL
AREA CONTAMINATION
ASSESSMENT REPORT,
1988

Job No. : 22238-4400

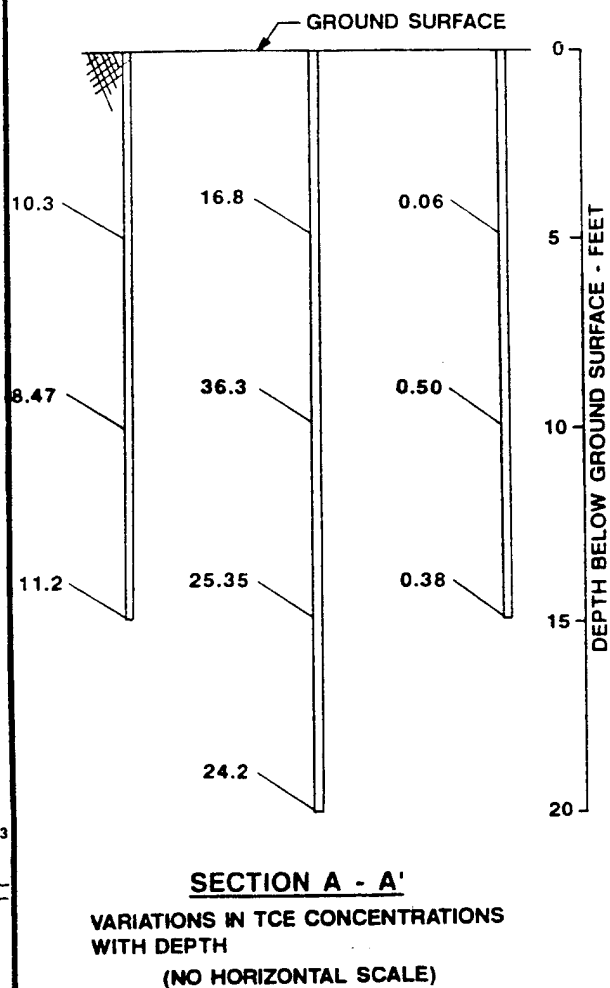
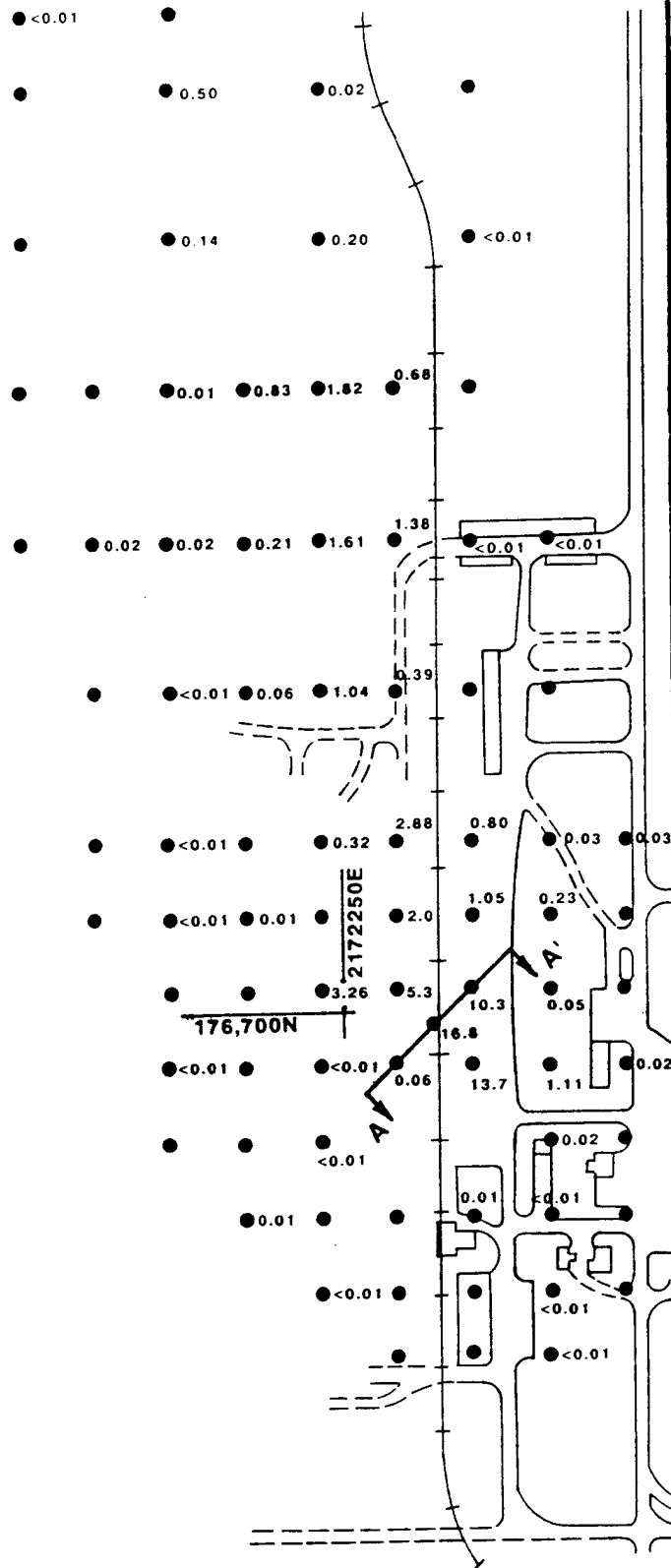
Prepared by : K.A.S.

Date : 12/18/89

MOTOR POOL AREA PILOT STUDY VICINITY MAP

ROCKY MOUNTAIN ARSENAL, COLORADO

Figure 2-2



ALL TCE VALUES INDICATED IN PLAN ARE AT 5 FT. DEPTH.
 VALUES ARE AS ug/l SOIL GAS



0 250 500 1000
 SCALE IN FEET

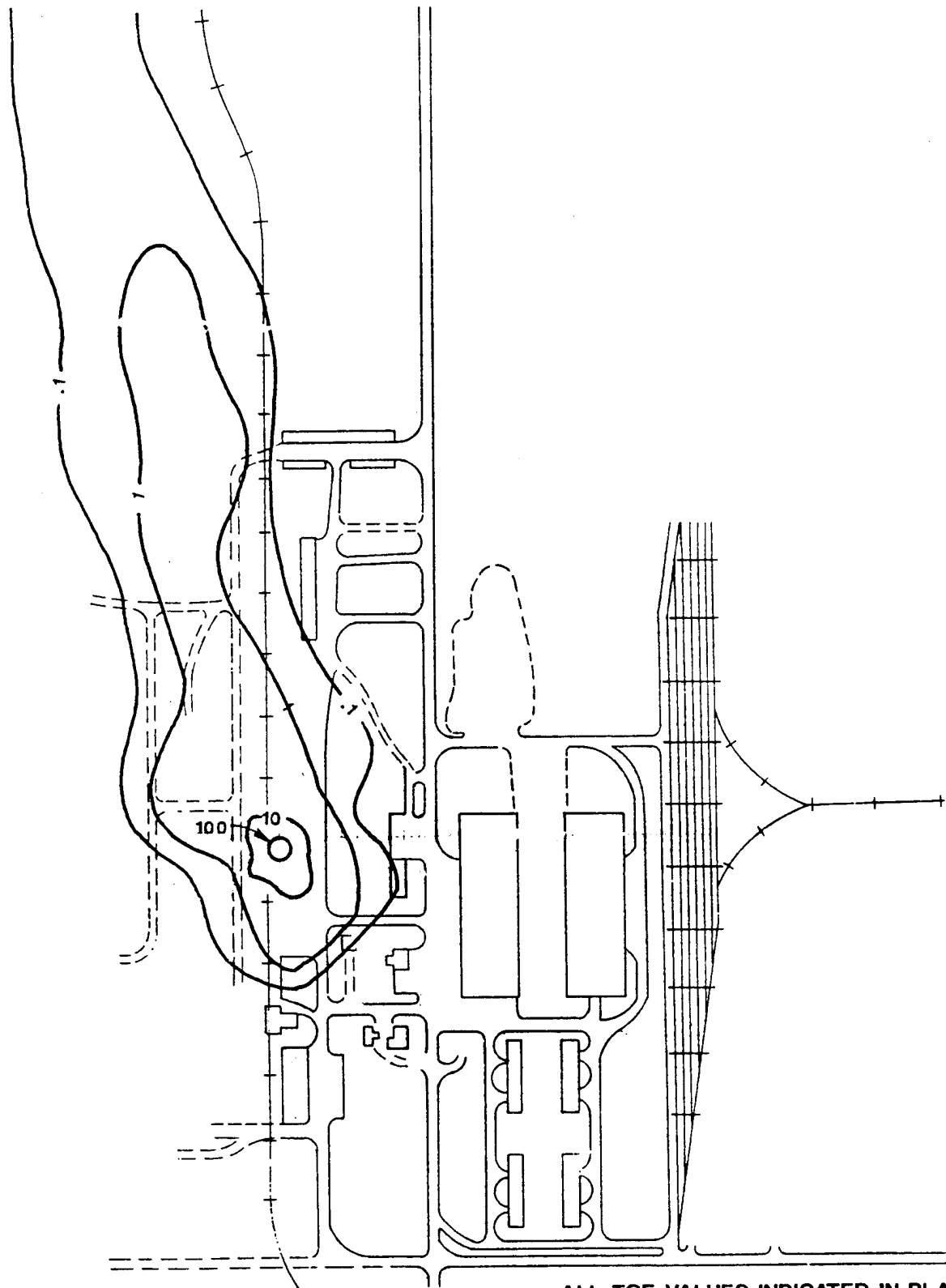
Job No. : 89MC114G

Prepared by: R.A.B

Date: 10/29/90

MOTOR POOL AREA PILOT STUDY
 1989 TCE SOIL GAS SURVEY
 ROCKY MOUNTAIN ARSENAL, COLORADO

Figure 2-3



ALL TCE VALUES INDICATED IN PLAN
ARE AT 5 FT. DEPTH.

LEGEND

10 TCE in $\mu\text{g/l}$ soil gas

Job No. : 22238-4400

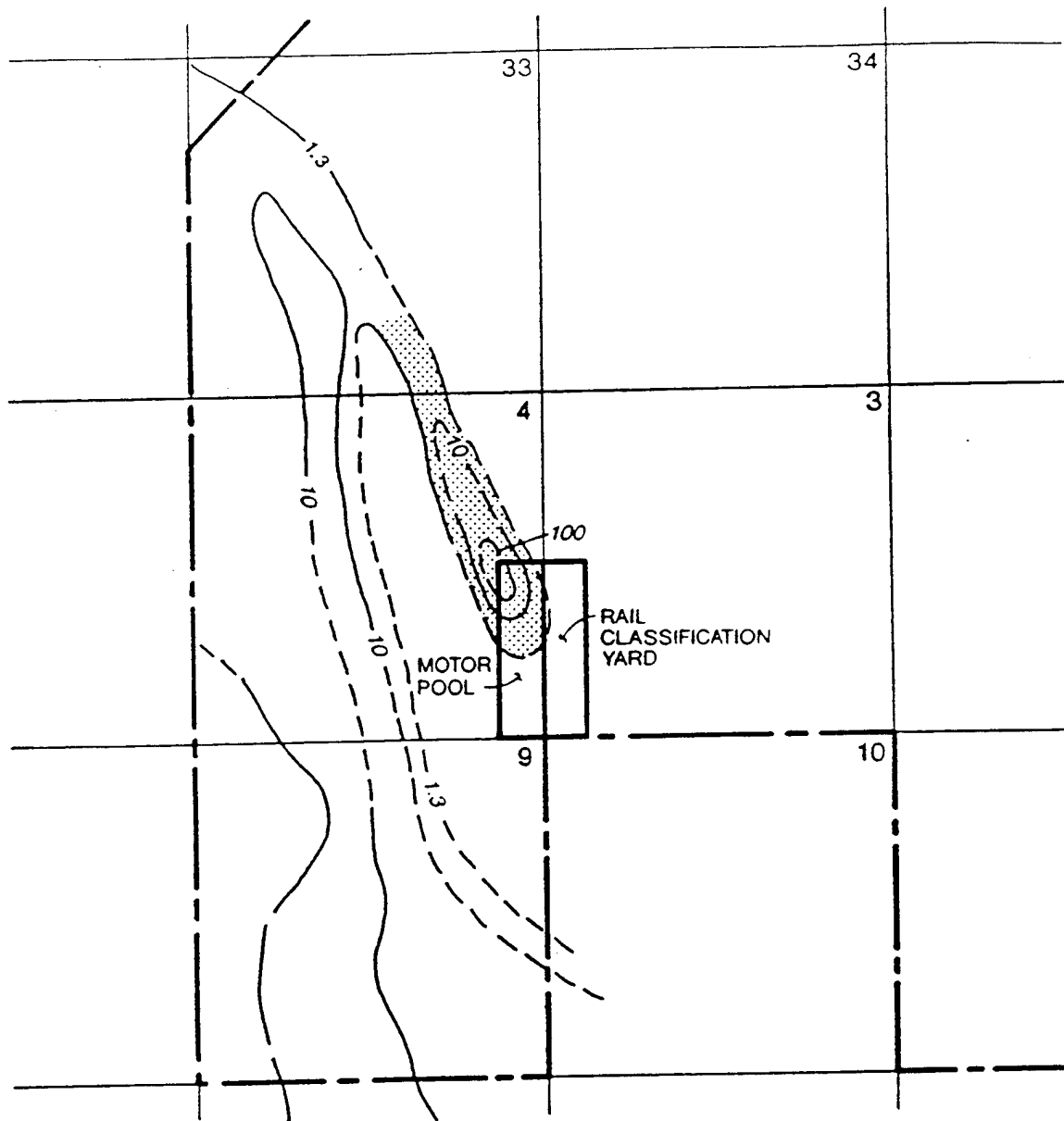
Prepared by : H.W.M./K.A.S.

Date : 12/18/89

MOTOR POOL AREA PILOT STUDY
1989 SOIL GAS SURVEY
ISO-CONCENTRATION PROFILE
ROCKY MOUNTAIN ARSENAL, COLORADO

Figure 2-4



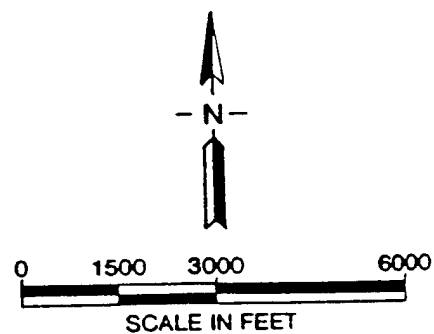


LEGEND

- Isoconcentration Line, Dashed where Inferred
- TCE Plume Emanating from the Motor Pool Area
- RMA Boundary

1.3
 10
 100
 1000
 2000

Isoconcentration Values (ug/l)



SOURCE: Figure 4.3-19 Trichloroethene
 (E) Plumes/Unconfined
 Groundwater Flow System/Winter
 1987/88 CMP Groundwater Monitoring
 Annual Report/Prepared by: R.L. Stollar
 & Associates Inc. Harding Lawson
 Associates

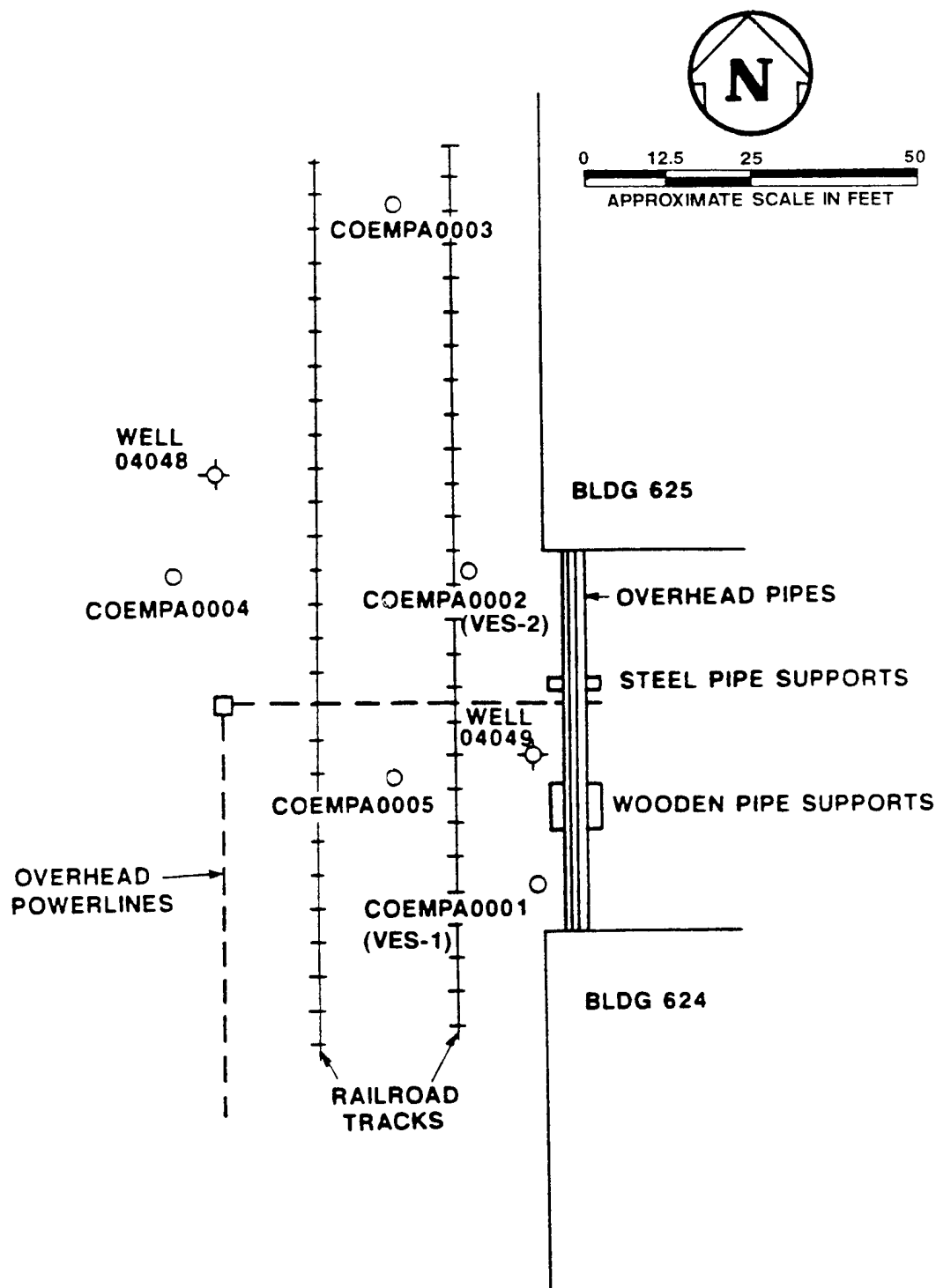
Job No. : 22765-4

Prepared by: R.E.S.

Date: 3/26/92

TCE GROUNDWATER PLUME

Figure 2-5

**LEGEND**

○ BORING COEMPA00X

NOTE:

BORING COEMPA0001 AND BORING COEMPA0002 WERE COMPLETED AS SOIL VAPOR EXTRACTION WELLS (VES-1 AND VES-2, RESPECTIVELY)

Job No. : 89MC114G

Prepared by: R.A.B.

Date: 10/9/90

**MOTOR POOL AREA PRE-DESIGN
STUDY BORING LOCATIONS**

ROCKY MOUNTAIN ARSENAL, COLORADO

FIGURE 2-6

TECHNICAL APPROACH

This section presents a description of the SVE system used for this pilot study and discusses details of the pilot test operation as well as the data collection and analysis program.

3.1 SYSTEM DESCRIPTION

In situ soil vapor extraction systems provide a method to remove volatile organic compounds (VOCs) from contaminated soil. When operated properly, an SVE system can be one of the most cost-effective remediation processes for soils contaminated with gasoline, solvents, or other volatile compounds. When an SVE system is applicable, partial or complete remediation is possible using simple equipment, with minimal requirements for intrusive procedures such as excavation, and with little or no contaminated materials requiring disposal.

An SVE system, in its simplest form, consists of one or more extraction wells, a separation tank to remove entrained or condensed water, and a vacuum blower to draw vapors containing the volatile contaminants from the soil. Often, the extracted vapors may be discharged directly to the atmosphere. In some cases, because of regulatory requirements or health risks, above-ground treatment of the extracted vapors may be required. Treatment technologies commonly employed include adsorption of the vapor phase organic compounds on granular activated carbon (GAC) or thermal/catalytic treatment of the organic vapors.

3.1.1 Extraction and Monitoring Wells

As shown in Figure 3-1, two soil borings were completed as extraction wells (VES-1 and VES-2) during the 1990 soil sampling event. A one-day study was performed using these wells and a mobile SVE system to gather preliminary data to aid in the design of the pilot system. Based on the air permeability data obtained during this study, extraction wells VES-3 and VES-4 were installed for the pilot test. VES-3 was screened from

approximately 13 to 28 below ground surface (bgs) and was used for testing the shallow extraction zone. VES-4 was screened from approximately 43 to 58 feet bgs for testing a deeper screened interval. The purpose of extracting from both a deep and shallow zone was to assess the optimal screened interval for future vapor extraction wells in the event that the pilot test results indicated that additional vapor extraction wells were appropriate. The SVE system designed for this pilot study can be easily scaled up to accommodate additional extraction wells.

Based on the suspected plume gradient, four clusters of soil gas monitoring wells were installed at the locations shown in Figure 3-1. Each cluster had a well screened in the following locations: a shallow interval, (A), within the range of approximately 12 to 14 feet bgs, to evaluate whether any significant short-circuiting occurred as a result of air being drawn in from the ground surface; an intermediate interval, (B), within the clay layer to evaluate the effect of the SVE system on soil gas within the low permeability lens (30 to 38 feet bgs); and a deep interval, (C), within the range of approximately 52 to 56 feet bgs and near the groundwater table, to evaluate temporal trends of soil gas concentrations near the groundwater. Soil gas monitoring wells P-5, P-6, and P-7 extended radially to the north of the extraction wells, while P-8 was located to the west of the wells to evaluate radial variations.

The soil gas monitoring probes consisted of a 1-foot long, 1-inch-diameter slotted (.02-inch slots) PVC pipe with caps on both ends. During installation, the soil gas monitoring probes were lowered into the 4-inch diameter borings to the previously specified depth. A coarse sand was backfilled around the probes. Each probe was connected to the surface with 1/4-inch diameter polyethylene tubing for monitoring the vacuum and TCE concentrations in the soil gas.

3.1.2 Above-Ground Equipment

The shallow and deep extraction wells were connected to the vacuum blower through an insulated PVC pipe installed on the ground surface. The blower and associated equipment were located in a temporary building near the northwest corner of Building 624. A liquid/vapor separator tank was installed between the extraction wells and the blower to allow for collection of any moisture that condensed from the gas stream. The

separation tank was equipped with an automatic vacuum relief valve, a vacuum gauge, a site gauge (to monitor the amount of water in the tank), a drain valve, and a liquid level float-operated switch to shut the system down, should the water level rise past a preset level. (No water was collected during the operation of this pilot unit.) An inline filter was installed prior to the blower to remove any fines or silts which could damage the blower impeller. A regenerative blower driven by a 10-hp electric motor, capable of moving 250 cubic feet per minute (cfm) at 30 inches of water (vacuum) was selected for this pilot system. This belt-driven blower had the capability of operating under a wide range of conditions. To remove TCE from the extracted gas, the exhaust air was discharged to a series of GAC canisters. The first series of vapor phase GAC canisters was capable of removing approximately 90 percent of the TCE from the extracted gas, while the second series of canisters served as polishing units. Refer to Figure 3-2, Process Flow Diagram, for locations of the monitoring instrumentation and sampling ports.

3.2 PILOT TEST OPERATION AND DATA COLLECTION PROGRAM

The Rocky Mountain Arsenal Motor Pool Area pilot test consisted of two sequential phases: short-term operation and long-term operation. Data was collected during these two phases of operation to provide information to meet the following objectives:

- Evaluate the horizontal and vertical soil gas VOC distribution at the Motor Pool Area to attempt to identify the nature or source of TCE.
- Evaluate the effectiveness of soil vapor extraction at the site.
- Evaluate the optimal extraction interval and operating conditions, based on observed pressure distributions, flow rates, and soil gas VOC distributions.

3.2.1 Short-Term Operation

The short-term operation period was conducted during the first four weeks of the pilot test where soil gas was extracted from VES-3 (shallow) for two weeks and then from

VES-4 (deep) for the two remaining weeks. Field sampling and analysis was performed on the first, third, and fifth days of both weeks, and laboratory analysis was performed on the first, third, and fifth days of the first week and in the middle of the second week. This program was repeated during weeks 3 and 4 when soil gas was extracted from the deep interval.

3.2.2 Long-Term Operation

The long-term operation began immediately following the short-term operation period and continued for approximately four additional months. Soil gas was extracted from the shallow interval during the first part of the long-term operation. Soil gas extraction continued at a steady state for approximately two weeks. System operation was then suspended for one week. This cycle was repeated three times while extracting soil gas from the shallow unit. Soil gas was then extracted from the deep interval, and the same cycle (steady state, recovery) was repeated three times.

3.2.3 Data Collection

The data collected from the short-term operation is summarized in Table 3-1, and the data collected from the long-term operation is summarized in Table 3-2. Field data collection included recording of barometric pressure; pressure readings at the extraction well (VES-3 or VES-4), separation tank, before the first GAC unit, between the two GAC units, after the second GAC unit, and at all three depths of each of the four soil gas monitoring wells; temperature readings before and after the GAC units; and flow rate of the extracted gas from the orifice meter. These data were used to evaluate operating parameters for remediation.

Field sampling and analysis was performed using TCE-specific Sensidyne tubes and/or a photoionization detector (H_{Nu}) at the following 15 points: gas extracted from either VES-3 or VES-4; gas between the two GAC units; gas after the second GAC unit; at all three depths for each of the four soil gas monitoring wells.

Confirmation sampling and analysis consisted of taking samples and sending the samples to a laboratory for chemical analysis. A modified NIOSH method using a Gilian®

personal sampling pump and charcoal tube samples was used for the confirmation sampling and analysis. Confirmation sampling and analysis was done at the following 14 points: gas extracted from either VES-3 or VES-4; gas after the second GAC unit; at all three depths of each of the four soil gas monitoring wells.

The long-term operation consisted of the six cycles as described above, with three cycles for shallow extraction and three cycles for deep extraction. Each cycle consisted of an initial sampling round followed by approximately two weeks of steady state operation and one week of suspended operation. Field data, field samples, and lab samples were collected at the beginning of each cycle. During steady state operations, field data were collected three times each week, field samples at the beginning and end of the week, and a lab sample was taken from the extraction well at the end of the week. At the end of the third cycle, the initial sampling set was performed at the end of the week of suspended operations, before the program was repeated in the deep interval.

Data were analyzed to evaluate the potential source(s) of the soil gas VOC concentrations, and to identify operating parameters for the SVE system during this program. Vacuum distribution was evaluated to determine flow patterns and chemical analysis was evaluated to estimate system performance. Analytical chemistry results can be found in Appendix B.

TABLE 3-1

**SHORT-TERM OPERATION MONITORING PROGRAM
MOTOR POOL SVE PILOT TEST**

Period of Operation	Field Data Collection ¹		Field Sampling & Analysis ² (15 Sampling Points)		Laboratory Analysis ³ (14 Sampling Points)	
	Frequency	No. of Sampling Events	Frequency	No. of Sampling Events	Frequency	No. of Sampling Events
Short-term Operation - Shallow Extraction (VES-3)						
First Week	Daily	5	First, third, and fifth day	3	First, third, and fifth day	3
Second Week	Daily	5	First, third, and fifth day	3	Once (mid-week)	1
						51
						17
Short-term Operation - Deep Extraction (VES-4)						
Third Week	Daily	5	First, third, and fifth day	3	First, third, and fifth day	3
Fourth Week	Daily	5	First, third, and fifth day	3	Once (mid-week)	1
						51
						17
Total				12		8
						180
						136

TABLE 3-1
(Concluded)

- 1 Field data collection includes recording of: pressure readings at the extraction well (VES-3 or VES-4), separation tank, before the first GAC unit, between GAC units, after the second GAC unit, and at each of the three intervals (shallow, medium, and deep) of each of the four monitoring wells; temperature readings before and after the GAC units; flow rate of extracted gas from the orifice meter; and field conditions (temperature, weather conditions, barometric pressure).
- 2 Field sampling and analysis involves the use of TCE-specific draeger tubes (or equivalent) and/or a photoionization detector at 15 sampling points: the extraction well (VES-3 or VES-4); gas between the GAC units; gas after the second GAC unit; and gas from each of the three intervals (shallow, medium, and deep) of each of the four monitoring wells.
- 3 Samples from 14 sampling points will be analyzed for VOC concentrations: the extraction well (VES-3 or VES-4); gas after the two GAC units; and gas from each of the three intervals (shallow, medium, and deep) of each of the four monitoring wells.
- 4 Total number of samples includes a duplicate, field blank, and trip blank (QA/QC samples) for each sampling event (i.e., total number of samples = no. of sampling events x (14 sampling points + 3 QA/QC samples)).

TABLE 3-2
LONG-TERM OPERATION MONITORING PROGRAM
MOTOR POOL SVE PILOT TEST

Field Data Collection ¹		Field Sampling & Analysis ² (15 Sampling Points)		
Period of Cycle	Frequency	No. of Sampling Events	Frequency (per cycle)	Total Number of Sampling Events (for 3 cycles)
Initial Sample	Once	1	Once	1
Steady State	Three times per week	6	At beginning and end of each week	12
Recovery	Three times per week	3	Once	3
Total for Three Cycles (shallow well)				16
Total for Long-term Operation (shallow and deep well)				32
				480

TABLE 3-2
(Concluded)

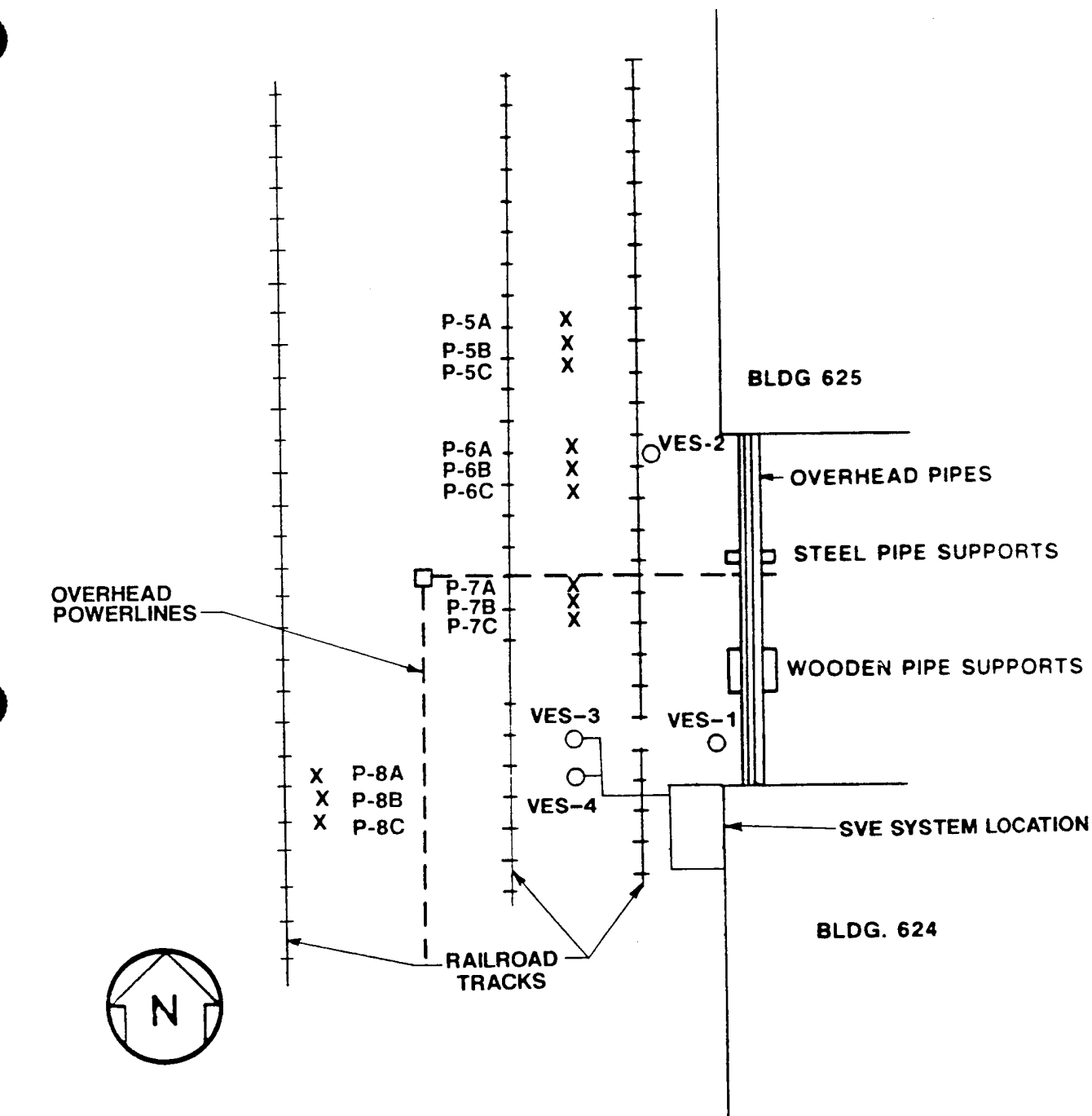
Laboratory Analysis ³					
Period of Cycle	Frequency (per cycle)	No. of Sampling Events (per cycle)	Frequency (for 3 cycles)	Total No. of Sampling Events (for 3 cycles)	Total Number of Samples ⁴
Initial Sample	Once	1	1	1	17
Steady State	At end of week	2	3	6	24
Recovery	Once	1	3	3	51
Total for Three Cycles (shallow well)				10	92
Total for Long-Term Operation (shallow and deep well)				20	184

¹ Field data collection includes recording of: pressure readings at the extraction well (VES-3 or VES-4), separation tank, before the first GAC unit, between GAC units, after the second GAC unit, and at each of the three intervals of each of the four monitoring wells; temperature readings before and after the GAC units; flow rate of extracted gas from the orifice meter; and field conditions (temperature, weather conditions, barometric pressure).

² Field sampling and analysis involves the use of TCE-specific Draeger tubes (or equivalent) and/or photoionization detector at 15 sampling points: the extraction well (VES-3 or VES-4); gas between the GAC units; gas after the second GAC unit; and gas from each of the three intervals of each of the four monitoring wells.

³ Samples from 14 sampling points will be analyzed for VOC concentrations: the extraction well (VES-3 or VES-4); gas after the two GAC units; and gas from each of the three intervals of each of the four monitoring wells. When only one sampling point is specified, that point is the extraction well (VES-3 or VES-4).

⁴ Total number of samples includes a duplicate, field blank, and trip blank (QA/QC samples) for each sampling event (i.e., total number of samples = total no. of sampling events x (14 sampling points + 3 QA/QC samples))



0 12.5 25 50
APPROXIMATE SCALE IN FEET

LEGEND

- VES-1 ○ SOIL VAPOR EXTRACTION WELL
P-5A X SOIL GAS MONITORING WELL

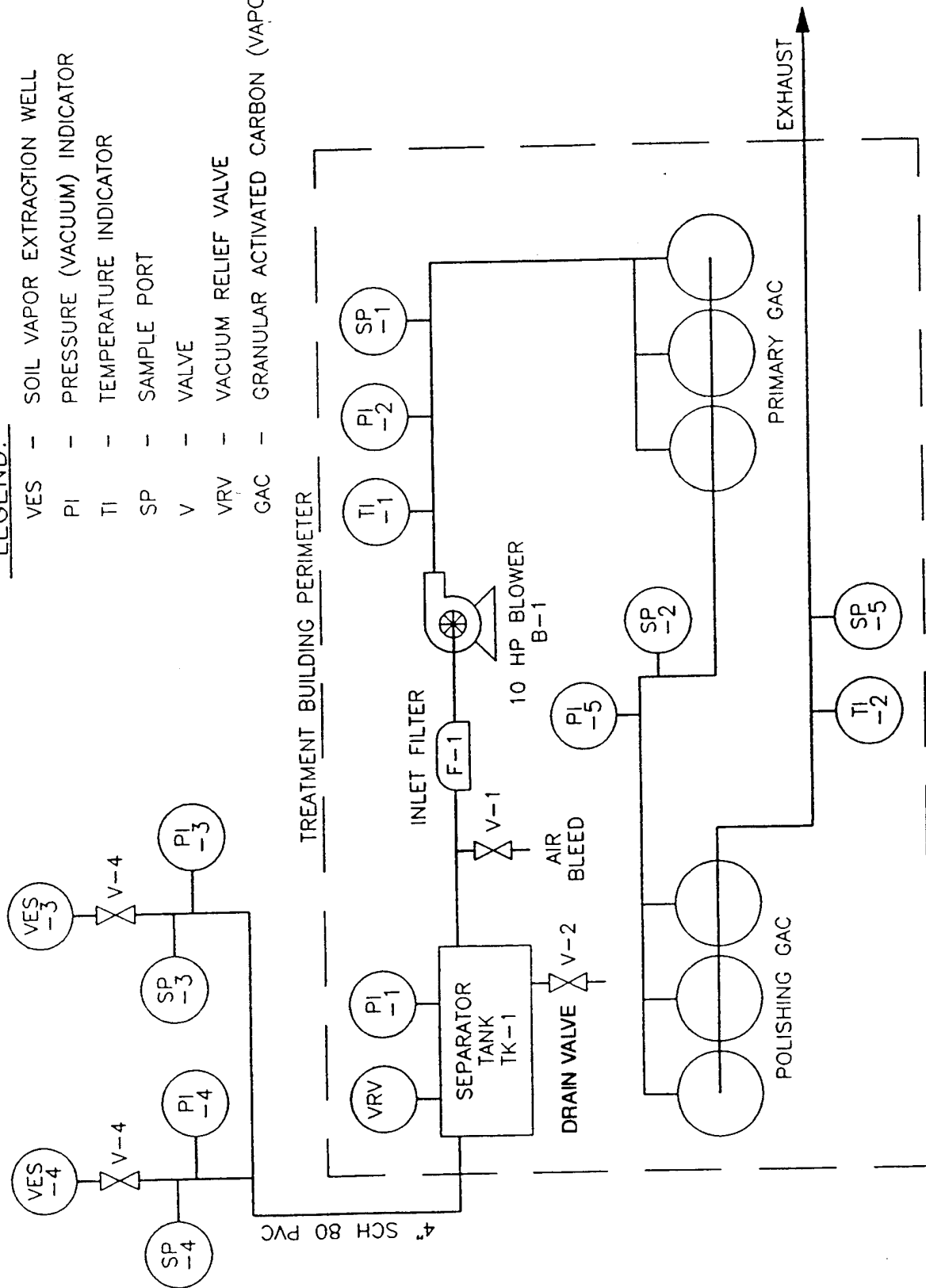
Job No. :	89MC114G1
Prepared by :	R.E.S.
Date :	12/10/91

MOTOR POOL AREA PILOT STUDY
SVE WELL LOCATIONS
ROCKY MOUNTAIN ARSENAL, COLORADO
Figure 3-1



LEGEND:

- VES - SOIL VAPOR EXTRACTION WELL
 PI - PRESSURE (VACUUM) INDICATOR
 TI - TEMPERATURE INDICATOR
 SP - SAMPLE PORT
 V - VALVE
 VRV - VACUUM RELIEF VALVE
 GAC - GRANULAR ACTIVATED CARBON (VAPOR PHASE)



Job No. : 89MC114G1	SOIL VAPOR EXTRACTION SYSTEM
Prepared by : RES	PROCESS FLOW DIAGRAM
Date : 12/10/91	MOTOR POOL AREA PILOT STUDY
Figure 3-2 	

OBSERVATIONS AND RESULTS

4.1 AIR PERMEABILITY TEST RESULTS

Prior to initiation of the data collection program, the soil permeability to air flow (a measure of the ability of air to pass through a porous media) was estimated to confirm the suitability of soil vapor extraction for this site. To calculate soil permeability, vacuum readings were taken at P-7B (representative of medium depth soil gas monitoring wells) at 5-minute intervals during system start-up. These readings were taken until steady state conditions were observed (approximately 30 minutes). Figure 4-1 shows a plot of vacuum at P-7B vs. the natural log of time when extracting from the shallow extraction well. This figure was used to predict the soil permeability to vapor flow in soils from the ground surface to approximately 38 feet bgs. The slope and Y-intercept of this plot were used in the following equation (Johnson et al., 1990) to predict soil permeability:

$$K = \frac{r^2 \epsilon \mu}{4 P_{\text{atm}}} \exp \left(\frac{B}{A} + 0.5772 \right)$$

where:

- r = radial distance from vapor extraction well, 22 feet
- ε = air-filled soil void fraction, 0.3
- μ = viscosity of air, 1.8 x 10⁻⁴ g/cm-s
- K = soil permeability to air flow (Darcys, or cm²)
- P_{atm} = ambient atmospheric pressure, 0.83 atm
- B = Y-intercept from plot of pressure vs. natural log of time
- A = slope from plot of pressure vs. natural log of time

This equation predicts a soil permeability to air flow of 167 darcys, indicative of silty to clean sand (Freeze and Cherry, 1979). The soil permeability to air flow was also estimated for extraction of soil gas from the deep extraction well (VES-4). Vacuum readings were taken at P-5C (62.5 feet radially from the extraction well) at 5-minute

intervals until steady state conditions were observed. Using Figure 4-2 and the same correlation, soil permeability to air flow was estimated at 2860 darcys. The higher permeability in the deeper region is indicative of clean sand to gravel. The high soil permeability-to-vapor flow, in both the shallow and deep regions, confirmed the suitability of soil vapor extraction to remediate contaminated soils at the RMA MPA.

4.2 SHORT-TERM OPERATION

The short-term operation of the pilot study was completed August 9, 1991. Figure 4-3 shows the TCE concentration in the blower exhaust decreasing from 51.6 mg/l or parts per million (ppm) to 10.6 ppm after the first week of extraction from the shallow well, VES-3. Figure 4-4 shows the TCE concentration in the blower exhaust decreasing from 18.3 ppm to 5.8 ppm during a 10-day period of extraction from the deep well VES-4. Comparing Figures 4-3 and 4-4, it can be seen that the initial TCE concentration detected in the blower exhaust was greater during the shallow well extraction. It may have been that the majority of the remaining TCE in the vadose zone is present above the clay lens. This suggests that the contribution from TCE re-volatilizing from the groundwater is probably minimal.

4.3 LONG-TERM OPERATION

Figures 4-5 and 4-6 show the TCE concentration measured at the blower exhaust during the long-term operation for both the shallow and deep extraction wells. The exhaust concentrations ranged from 2,500 parts per billion (ppb) to 4,300 ppb in the shallow extraction well and 2,400 ppb to 2,800 ppb in the deep extraction well. This was considerably less than observed during the short-term operation, indicating that the majority of TCE contamination had been removed during the initial operation of the pilot study. As expected, the TCE concentration continued to decrease until the system was shut down for the designated recovery period. The TCE exhaust concentration increased slightly when system operation was initiated after the recovery period. For example, in the shallow well, the TCE concentration increased from approximately 2,500 ppb to 3,800 ppb during an initial recovery period. The results of the intermittent flow or pulsing operations suggest that the volatilization of TCE was somewhat limited

by either diffusion of the adsorbed TCE on the soil or the dissolved TCE in the groundwater to the induced air stream.

Table 4-1 presents the overall results of the pilot study for both short and long-term operation including TCE concentrations in the soil gas monitoring wells. The concentration of TCE measured at the blower exhaust during the entire pilot study is shown graphically in Figure 4-7. As seen in this figure, the exhaust concentration decreased rapidly during the short-term operation but remained low and relatively consistent throughout the remainder of the study.

4.4 SYSTEM EFFECTIVENESS

Figures 4-8 and 4-9 represent the vacuum measured at the monitoring wells as a function of their distance from the extraction well. The nearest monitoring wells are P-7 A, B, and C, at a distance of approximately 22 feet. The farthest wells are P-5 A, B, and C, at 62.5 feet. Figure 4-8 represents vacuum decreases with respect to distance, as measured in the shallow soil gas monitoring wells when extracting from the shallow interval. As expected, the vacuum in the shallow soil gas monitoring wells decreased as the distance from the shallow extraction well increased. Appreciable vacuum (0.6 inches of water column) was still being measured 62.5 feet from the extraction well at monitoring well P-5A indicating the lack of a surface seal did not significantly reduce the radial influence of the shallow extraction well. The vacuum at the medium and deep soil gas monitoring wells, although considerably less than in the shallow zone, remained relatively constant, independent of distance from the extraction well. It appears the clay lens prevented the shallow extraction well from effectively influencing the deeper regions.

Figure 4-9 shows the vacuum distribution during deep well extraction. The small and relatively constant vacuum measured in the shallow soil gas monitoring wells (12 to 14 feet bgs) indicates that the clay is apparently providing an effective boundary to soil gas flow. As predicted, the vacuum decreased with distance from the deep extraction well in the medium and deep soil gas monitoring wells.

The concentration of TCE in each of the soil gas monitoring wells had decreased to non-detectable or low levels during the course of the pilot study. Figures 4-10 through 4-13 depict the rapid decrease in soil gas concentrations in the shallow monitoring wells after completion of the short-term operation. In the shallow monitoring wells, intermittent flow operation did not result in an expected rebound in soil gas concentrations in the later recovery periods, indicating that the shallow region had been completely remediated with extraction from the shallow well. Figures 4-14 through 4-17 and Figures 4-18 through 4-21 show TCE concentrations over time in medium and deep regions of the monitoring wells, respectively. As with the shallow region, the TCE concentrations in the medium and deep regions decreased dramatically during the short-term operation. As shown in these figures, the initial recovery phases during the long-term operation did result in corresponding small increases in TCE concentrations as measured in the soil gas monitoring wells. The later recovery phases produced no significant increase in TCE concentrations.

Table 4-2 presents a summary of the typical operating conditions recorded during the SVE pilot study.

Figure 4-22 shows a plot of the total mass TCE extracted over the pilot study, with approximately 67 lbs removed in approximately five months of system operation. Although 1,2-dichloroethene and vinyl chloride were analyzed for during the test, neither analyte was observed in any of the samples.

TABLE 4-1
SVE PILOT STUDY
SUMMARY OF ANALYTICAL RESULTS

Sampling Date	TCE Concentrations (ppm)													
	P-5A	P-5B	P-5C	P-6A	P-6B	P-6C	P-7A	P-7B	P-7C	P-8A	P-8B	P-8C	VES-3	VES-4
STS														
7-16-91	12.9	30.2	34.2	27.8	36.8	34.1	65.4	44.4	36.3	15.5	19.4	4.3		
7-17-91	23.5	6.3	ND	12.2	6.5	ND	7.6	10.8	ND	2.1	2.2	0.9	51.6	
7-19-91	5.3	20.0	23.4	6.5	20.1	26.5	ND	24.6	25.7	ND	11.6	11.9	16.7	
7-24-91	1.0	3.1	7.5	3.1	7.3	20.2	ND	14.4	8.3	ND	4.2	ND	10.6	
STD														
7-29-91	ND	2.1	ND	1.1	3.1	2.1	ND	3.1	2.1	ND	3.2	ND		18.3
7-31-91	ND	0.7	2.8	ND	1.4	ND	ND	ND	2.2	ND	2.1	2.2		13.6
8-2-91	ND	ND	0.7	ND	1.4	1.4	ND	ND	1.4	ND	2.1	ND		9.5
8-7-91	ND	ND	0.7	ND	1.4	1.5	ND	ND	1.4	ND	2.9	7.8		5.8
LTS														
8-12-91	ND	ND	2.8	ND	ND	ND	ND	ND	ND	ND	ND	2.1	3.6	
8-19-91	ND	0.7	ND	ND	0.7	2.8	ND	2.1	2.1	ND	0.7	2.1	3.5	
8-26-91	ND	1.1	0.4	ND	0.7	ND	ND	0.7	ND	ND	0.7	ND	2.7	
8-30-91	ND	1.1	ND	ND	0.7	0.4	ND	1.1	1.1	ND	0.4	0.7	--	
9-3-91	ND	0.4	0.7	ND	ND	0.4	ND	ND	3.9	ND	0.4	ND	4.3	
9-9-91	ND	ND	0.4	ND	ND	0.4	ND	ND	ND	ND	ND	1.0	2.8	
9-16-91	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.5	
9-20-91	ND	ND	ND	ND	ND	0.7	ND	ND	1.1	ND	0.4	ND	--	

TABLE 4-1
(Concluded)

Sampling Date	TCE Concentrations (ppm)													
	P-5A	P-5B	P-5C	P-6A	P-6B	P-6C	P-7A	P-7B	P-7C	P-8A	P-8B	P-8C	VES-3	VES-4
9-23-91	ND	0.7	0.7	ND	ND	2.0	ND	ND	ND	ND	0.3	1.0	3.6	
10-1-91	ND	0.5	1.2	ND	0.7	1.4	ND	1.1	1.6	ND	0.5	ND	2.8	
10-7-91	ND	0.7	0.4	ND	0.9	2.1	ND	0.7	2.3	ND	0.5	1.6	3.2	
LTD														
10-11-91	ND	0.5	1.6	ND	0.7	1.2	ND	0.4	2.0	ND	ND	1.9	--	
10-15-91	ND	0.3	0.7	ND	0.4	ND	ND	ND	ND	ND	0.4	2.1	2.6	
10-21-91	ND	ND	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.8	
10-28-91	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.4	ND	2.4	
11-1-91	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.7	
11-4-91	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.7	
11-11-91	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	
11-18-91	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.4	
12-2-91	ND	ND	ND	ND	ND	ND	ND	ND	1.1	ND	0.2	1.4	2.7	
12-9-91	ND	ND	ND	ND	ND	ND	ND	ND	0.6	ND	0.4	0.4	1.7	
12-16-91	ND	ND	ND	ND	ND	ND	ND	ND	0.2	ND	ND	0.4	2.8	

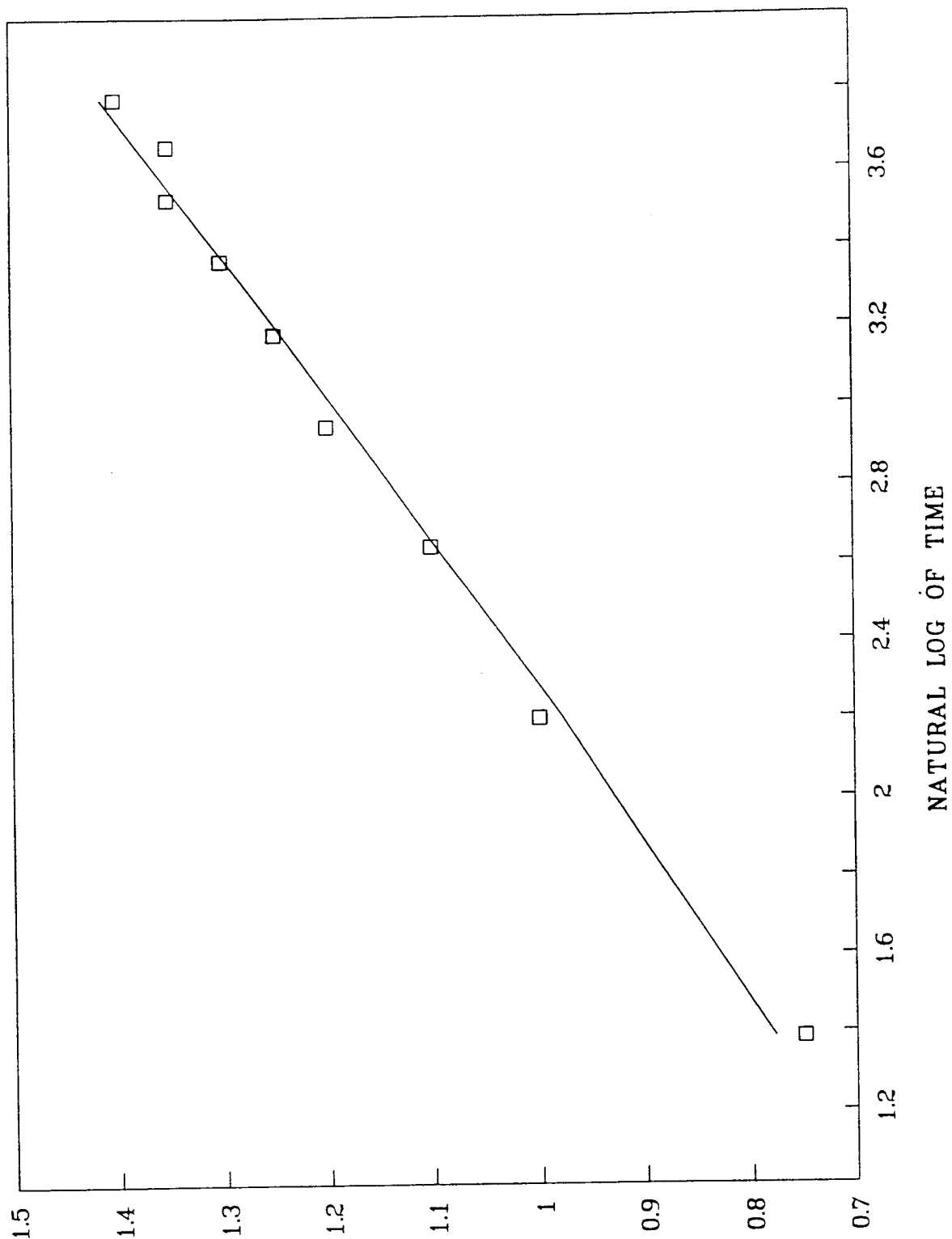
-- Sample not taken (recovery phase)
 ND Non Detect
 STS Short-term, shallow well (VES-3) extraction
 STD Short-term, deep well (VES-4) extraction
 LTS Long-term, shallow well (VES-4) extraction
 LTD Long-term, deep well (VES-4) extraction

TABLE 4-2
SVE PILOT STUDY
SUMMARY OF TYPICAL OPERATING CONDITIONS

Well	Vacuum (in. H ₂ O)
VES-3	0 - 13.8
VES-4	0 - 30
P-5A	0 - 0.74
P-5B	0 - 0.50
P-5C	0 - 0.50
P-6A	0.10 - 1.2
P-6B	0.4 - 1.55
P-6C	0 - 2.05
P-7A	0.32 - 1.80
P-7B	0.30 - 3.0
P-7C	0.30 - 3.05
P-8A	0 - 1.85
P-8B	0 - 2.10
P-8C	0 - 2.30

Separator Tank Vacuum (PI-1): 18.2 - 36.5 in H₂O
 Separator Level Gauge: 0 inches
 Blower Exhaust Temperature (TI-1): 123 - 153°F
 Blower Exhaust Pressure (PI-2): 8 - 12 in H₂O
 Blower Exhaust (SP-1):
 • HNU: 0 - 20 ppm
 • Sensidyne: 0 - 15 ppm
 • Velocity: 2,600 - 6,000 ft/min.
 • Flow Rate: 145 - 335 cfm

GAC Exhaust Temp (TI-2): 85 - 138°F
 GAC Exhaust Concentration (SP-5) (13.7 lbs/day state emission limit):
 • HNU: 0 - 3.7 ppm
 • Sensidyne: 0 ppm



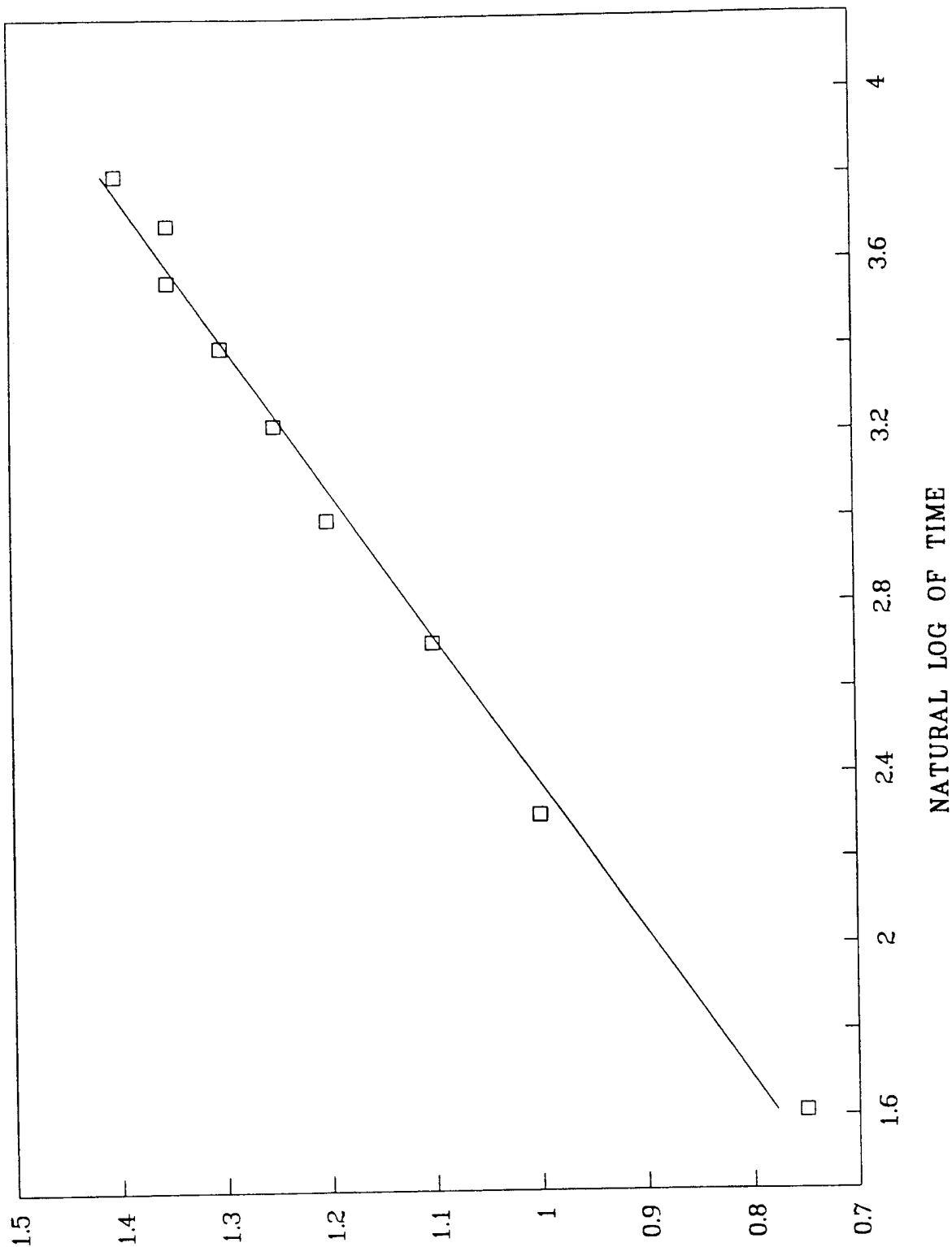
Job No. : 89MC114G1

Prepared by : M.A.G.

Date : 1/21/92

SOIL PERMEABILITY STUDY (VES-3)

ROCKY MOUNTAIN ARSENAL, COLORADO
Figure 4-1



VACUUM AT P-5C (INCHES OF WATER)

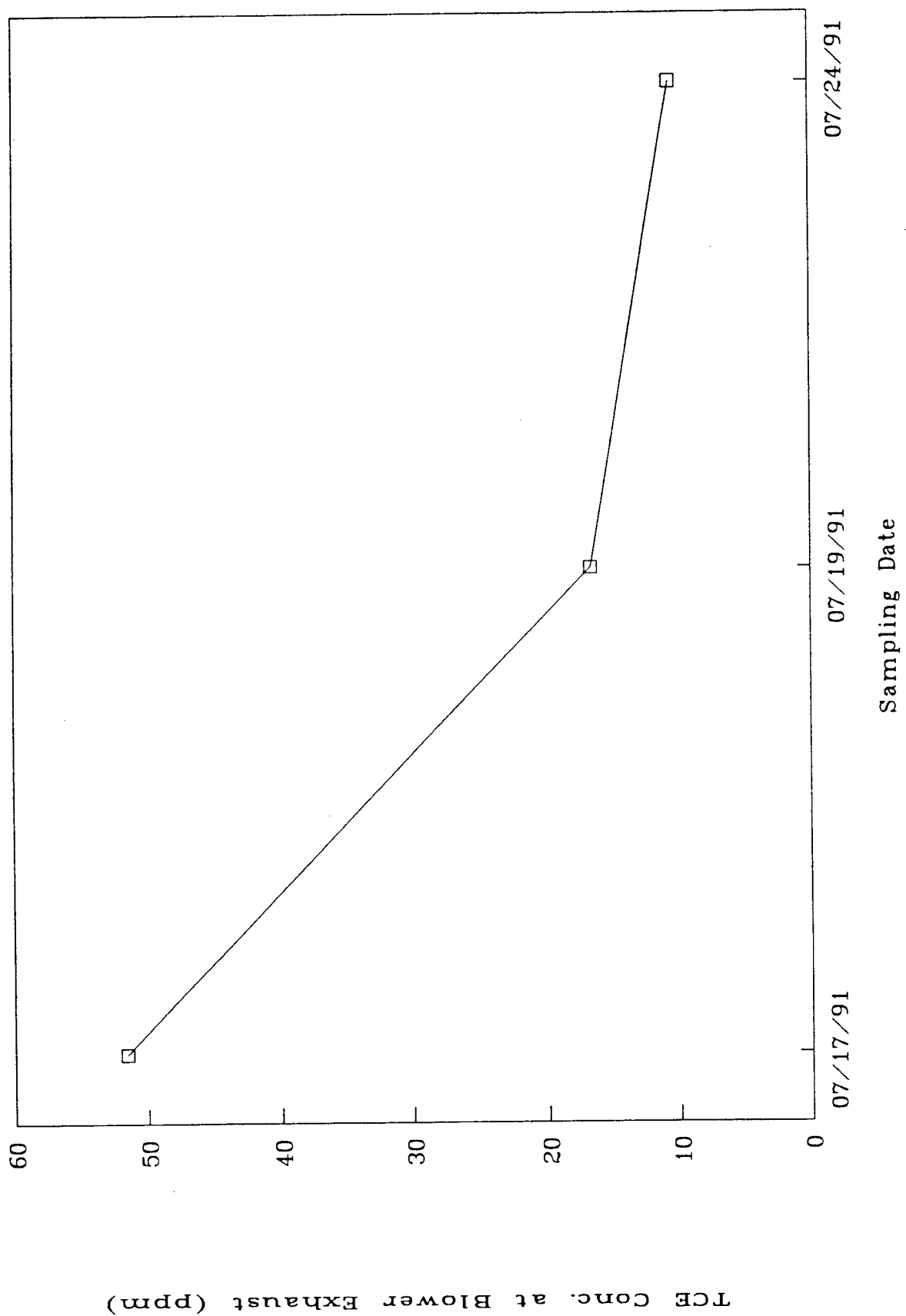
Job No. : 89MC114G1

Prepared by : M.A.G.

Date : 1/21/92

SOIL PERMEABILITY STUDY (VES-4)

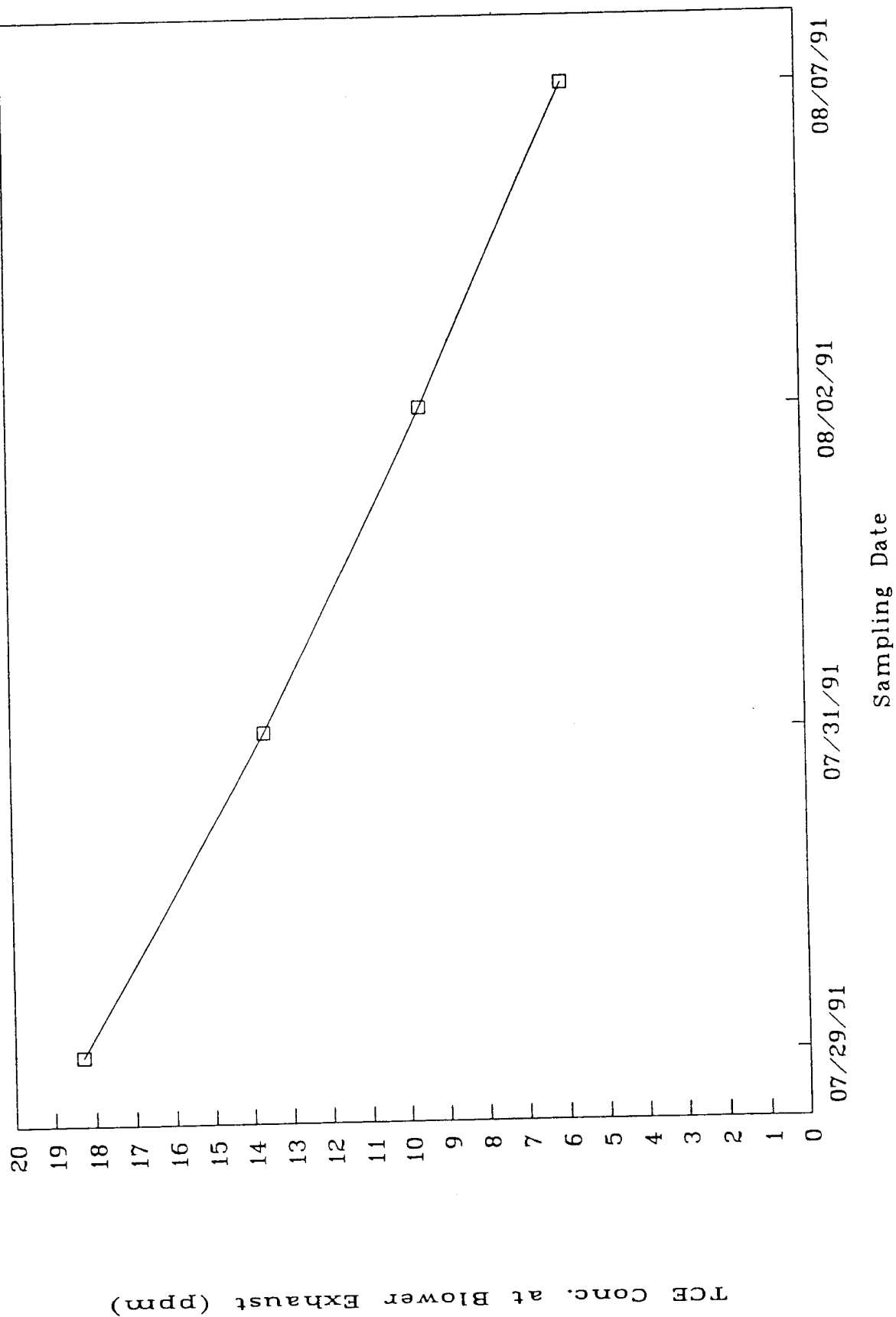
ROCKY MOUNTAIN ARSENAL, COLORADO
Figure 4-2



Job No. :	89MC114G1
Prepared by :	M.A.G.
Date :	1/21/92

**VES-3 SHALLOW WELL
SHORT TERM RESULTS**
ROCKY MOUNTAIN ARSENAL, COLORADO
Figure 4-3



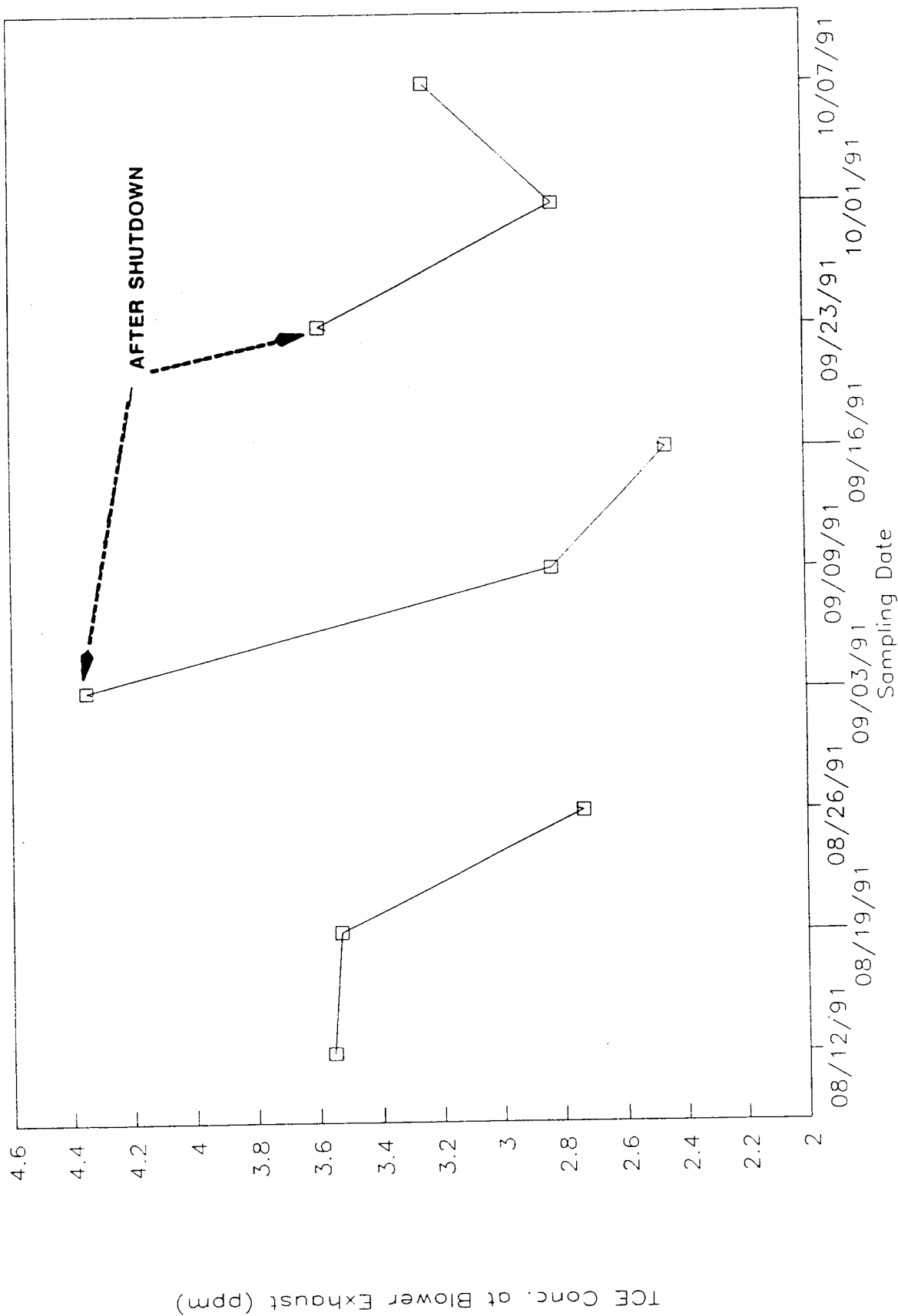


Job No. :	89MC114G1
Prepared by :	M.A.G.
Date :	1/21/92

VES-4 DEEP WELL SHORT TERM RESULTS

ROCKY MOUNTAIN ARSENAL, COLORADO
Figure 4-4





Job No. : 89MC114G1

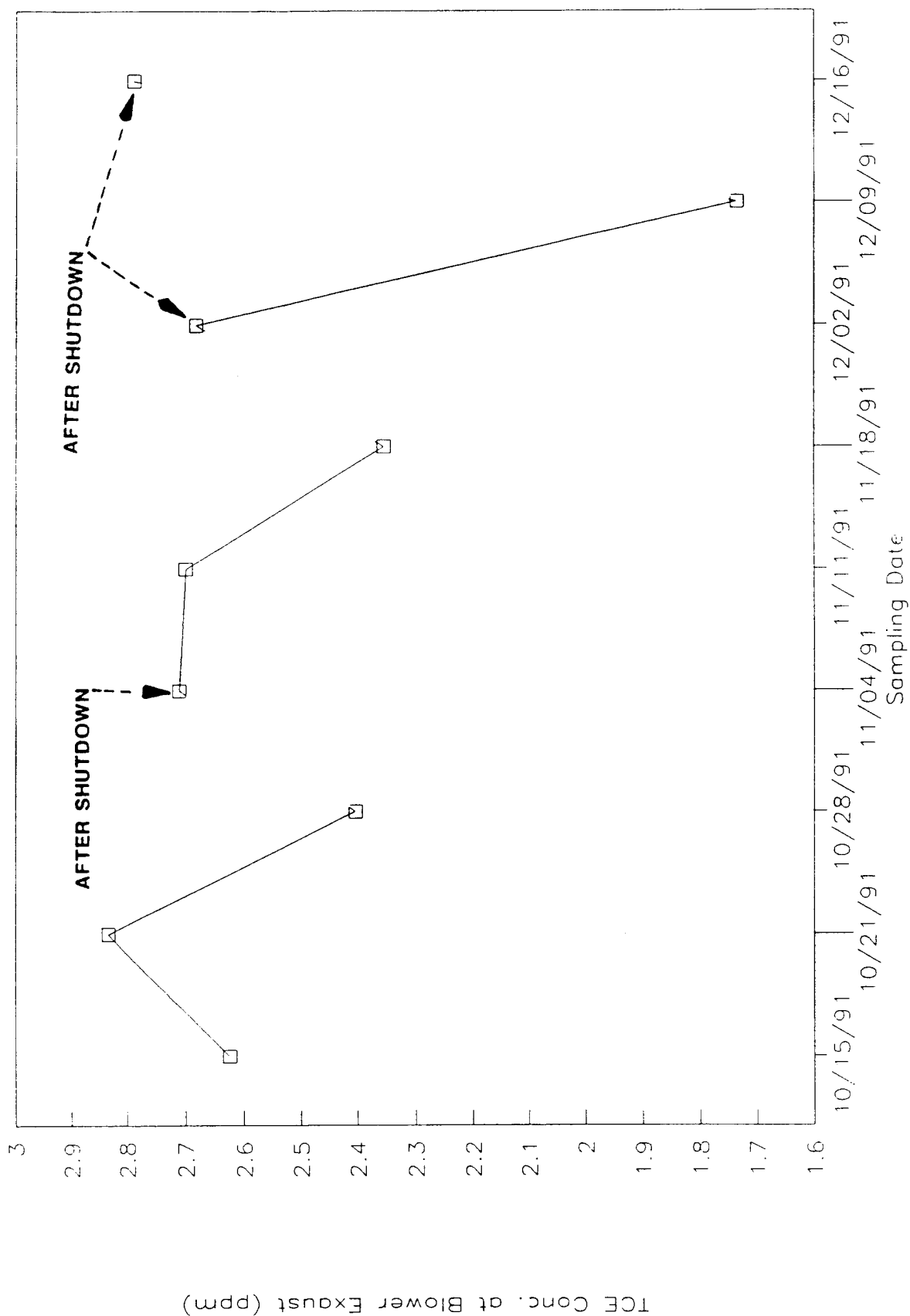
Prepared by : M.A.G.

Date : 1/21/92

VES-3 SHALLOW WELL LONG TERM RESULTS

ROCKY MOUNTAIN ARSENAL, COLORADO
Figure 4-5





Job No. : 89MC114G1

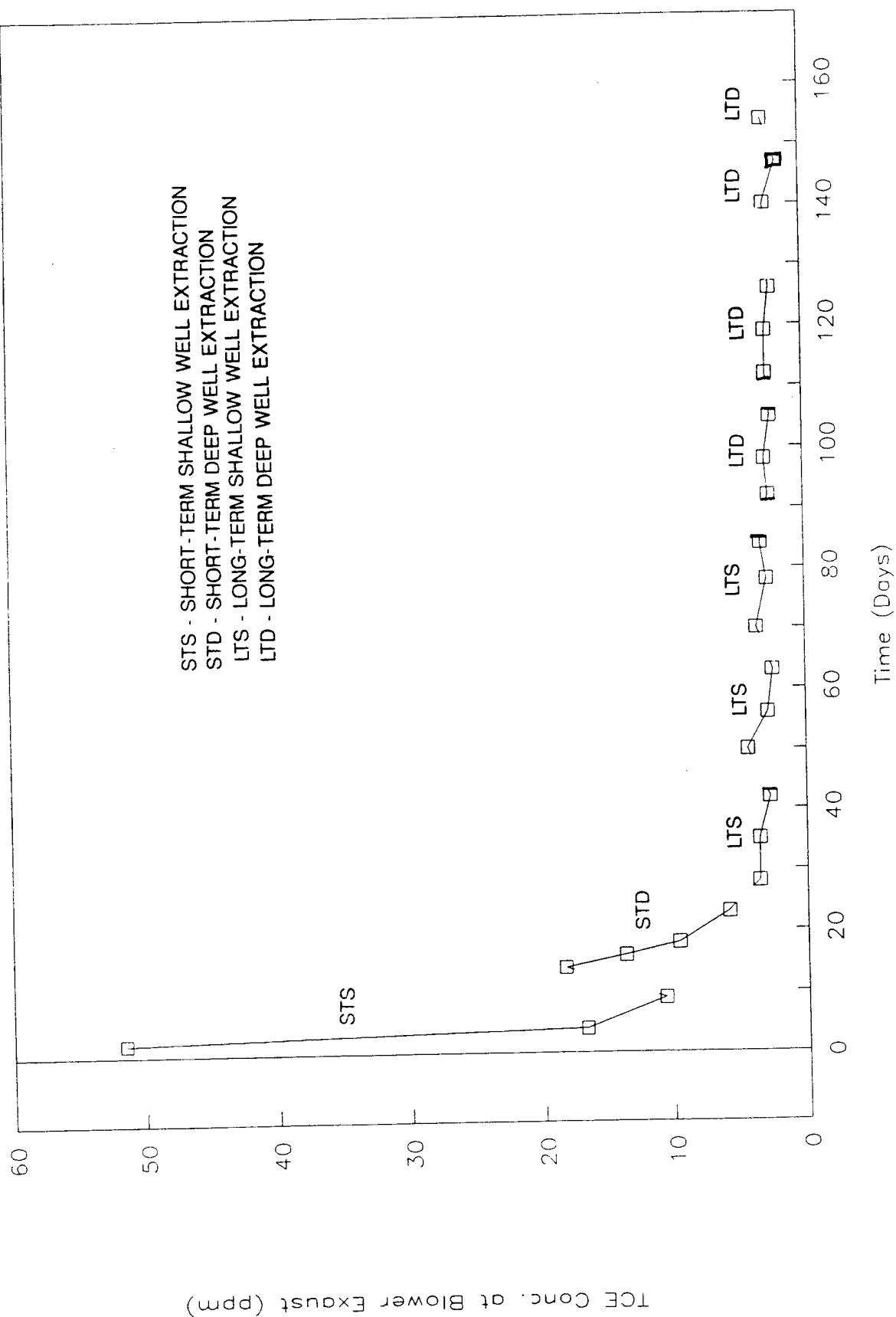
Prepared by : M.A.G.

Date : 1/21/92

VES-4 DEEP WELL LONG TERM RESULTS

ROCKY MOUNTAIN ARSENAL, COLORADO

Figure 4-6

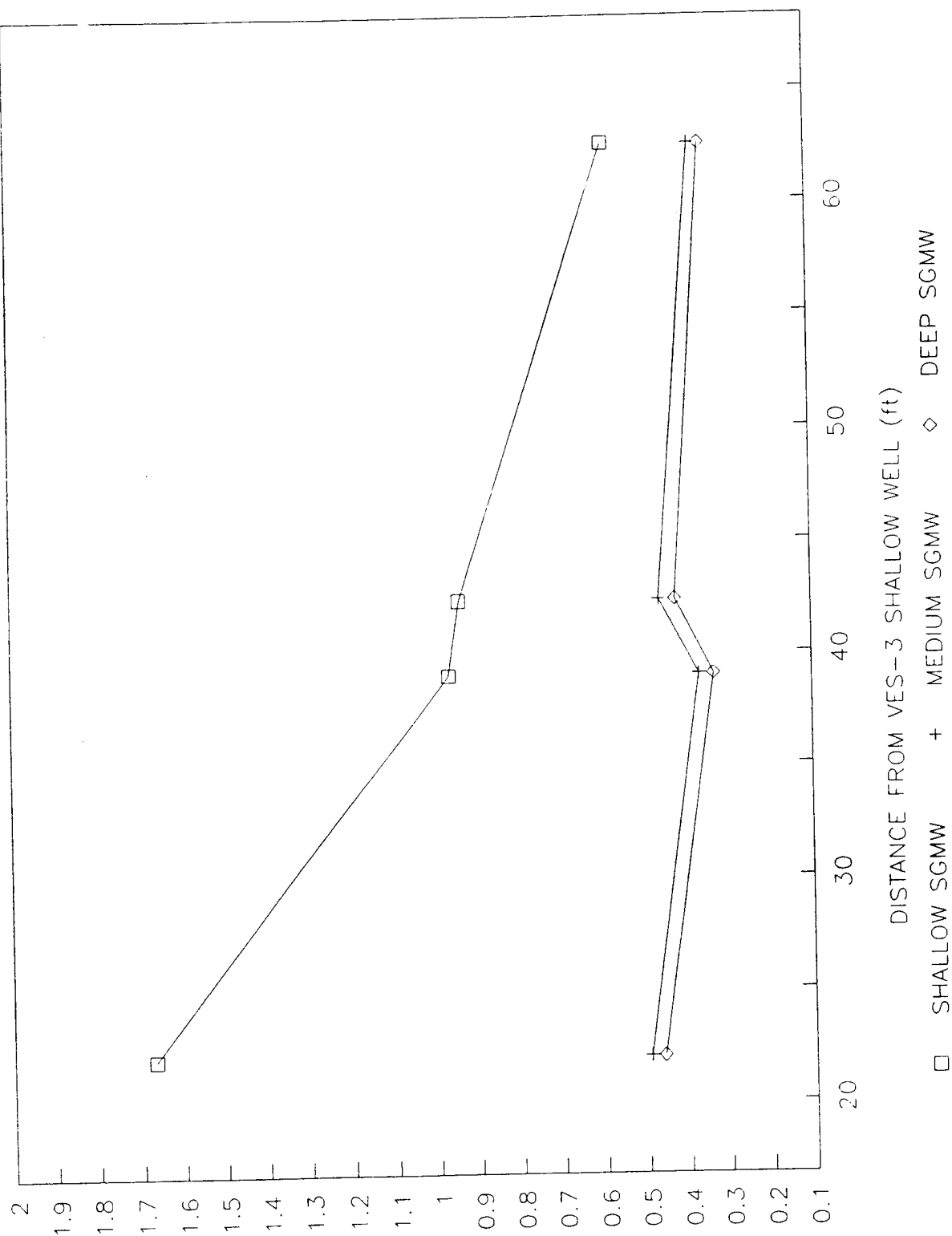


Job No. : 89MC114G1

Prepared by: M.A.G.

Date: 3/30/92

**SUMMARY OF LONG AND
 SHORT TERM OPERATIONS**
 ROCKY MOUNTAIN ARSENAL, COLORADO
Figure 4-7



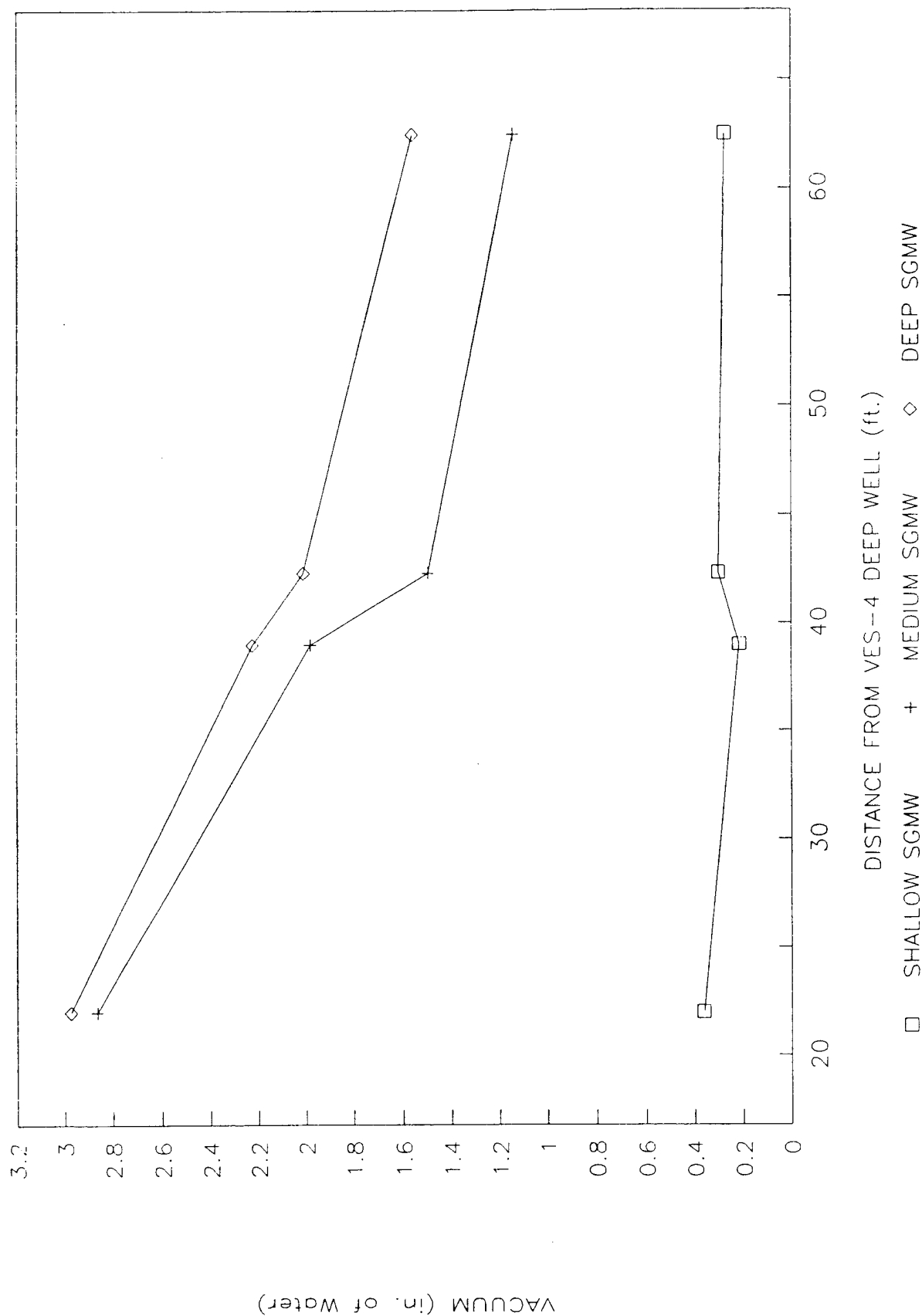
VACUUM (in. of Water)

Job No. : 89MC114G1

Prepared by : M.A.G.

Date : 1/21/92

SHALLOW EXTRACTION WELL
VACUUM READINGSROCKY MOUNTAIN ARSENAL, COLORADO
Figure 4-8



Job No. : 89MC114G1

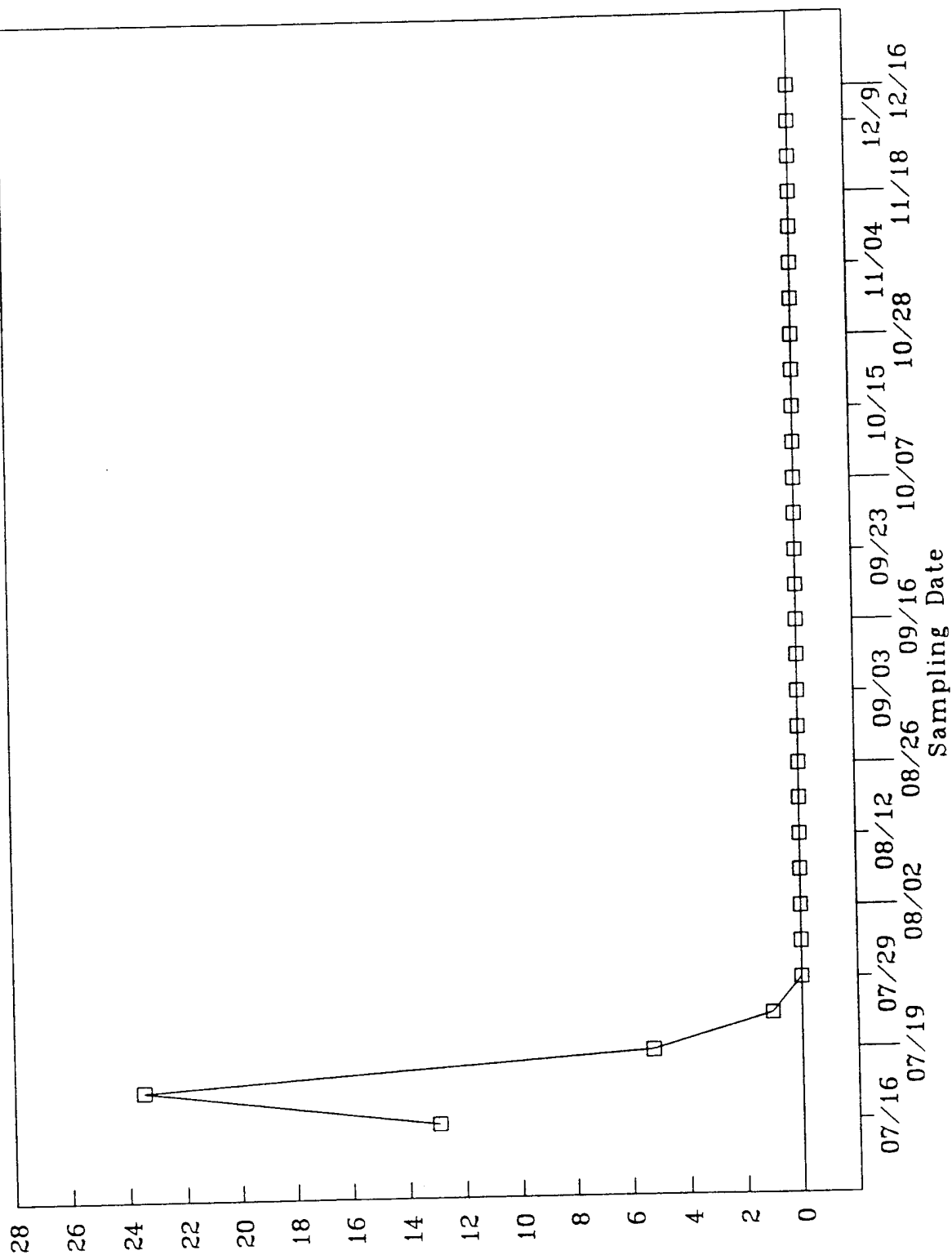
Prepared by: M.A.G.

Date: 1/21/92

DEEP EXTRACTION WELL VACUUM READINGS

ROCKY MOUNTAIN ARSENAL, COLORADO
Figure 4-9



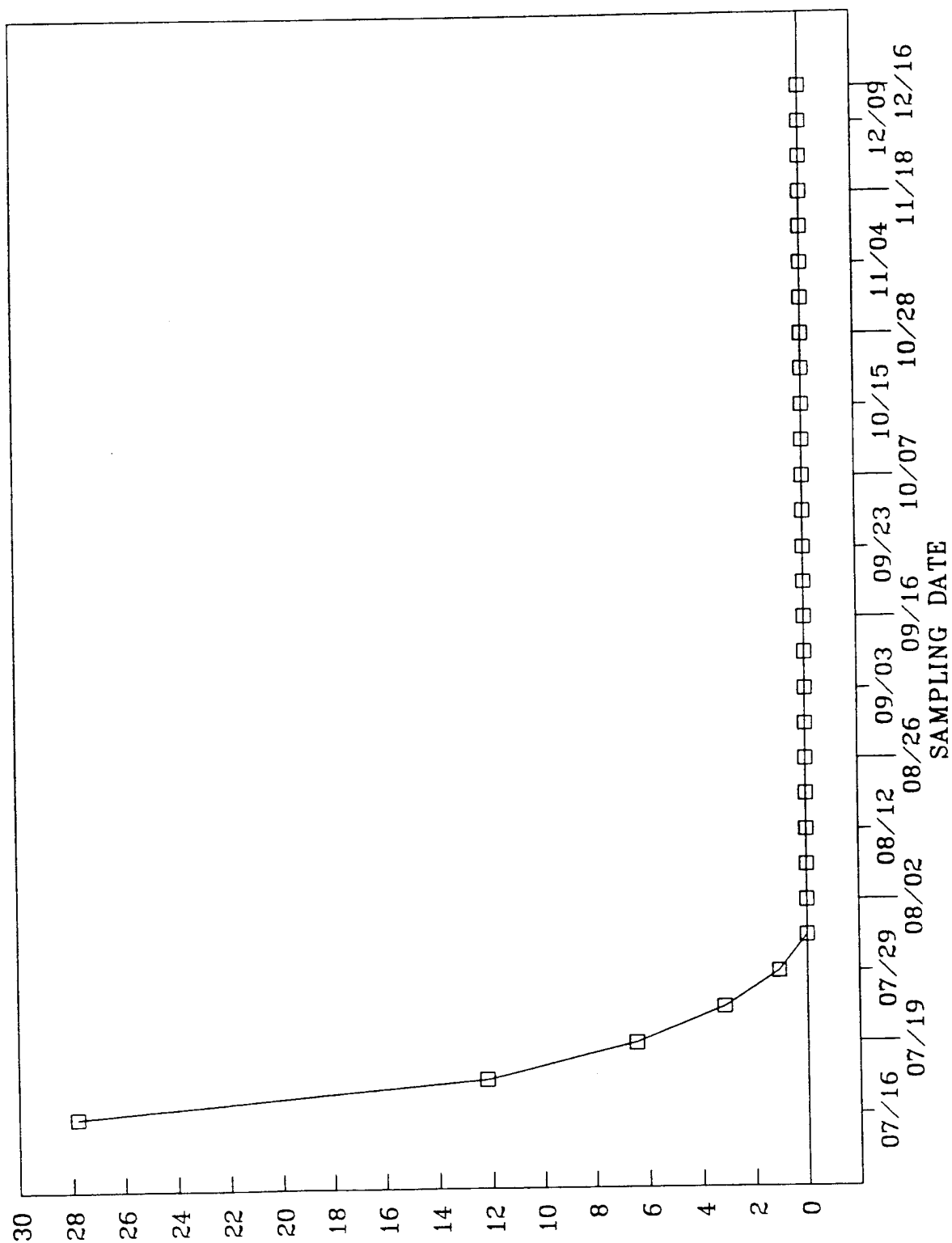


Job No. : 89MC114G1

Prepared by : M.A.G.

Date : 1/21/92

P-5A SHALLOW MONITORING WELLROCKY MOUNTAIN ARSENAL, COLORADO
Figure 4-10



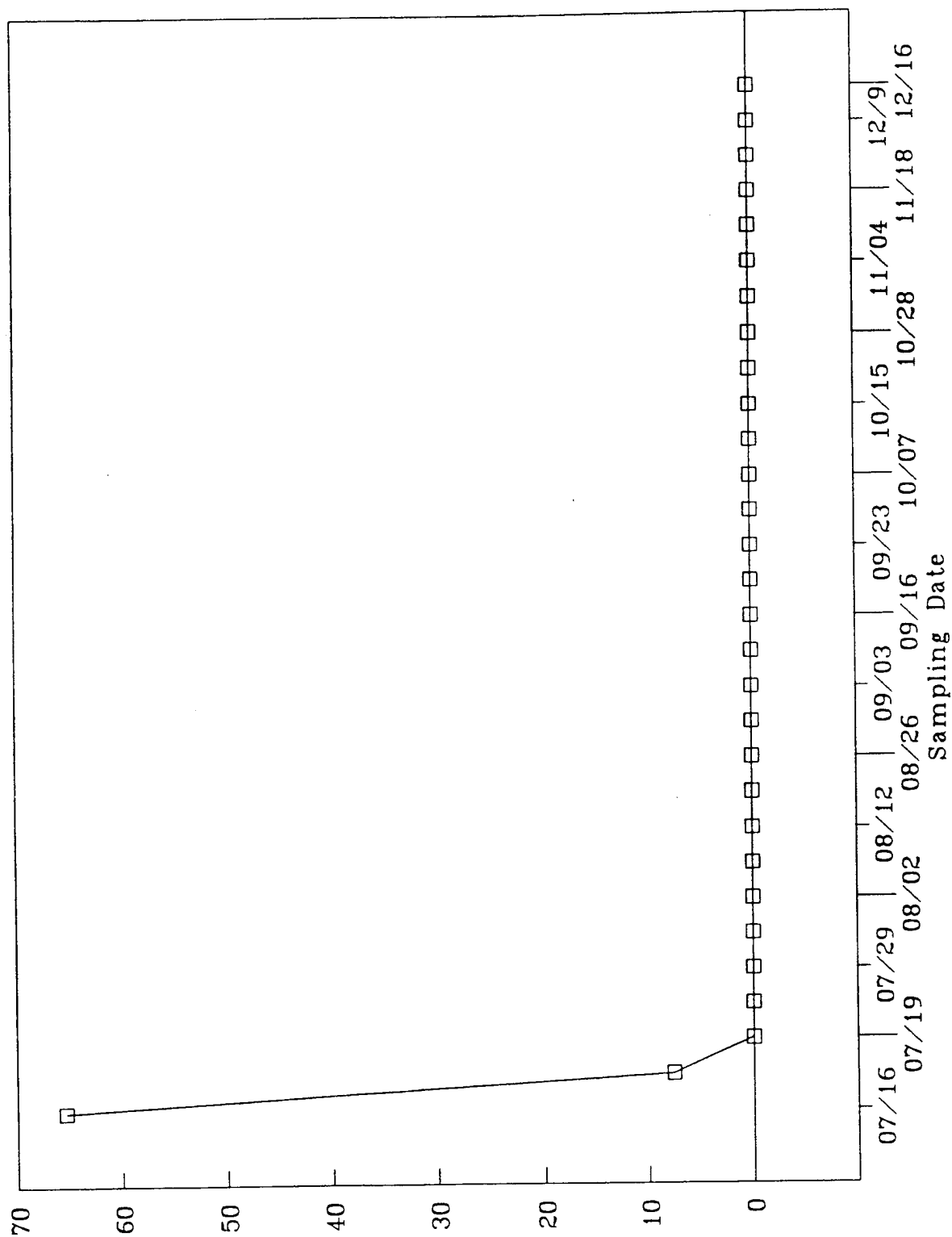
TCE Conc. At Monitoring Well (ppm)

Job No. : 89MC114G1

Prepared by : M.A.G.

Date : 1/21/92

P-6A SHALLOW MONITORING WELLROCKY MOUNTAIN ARSENAL, COLORADO
Figure 4-11

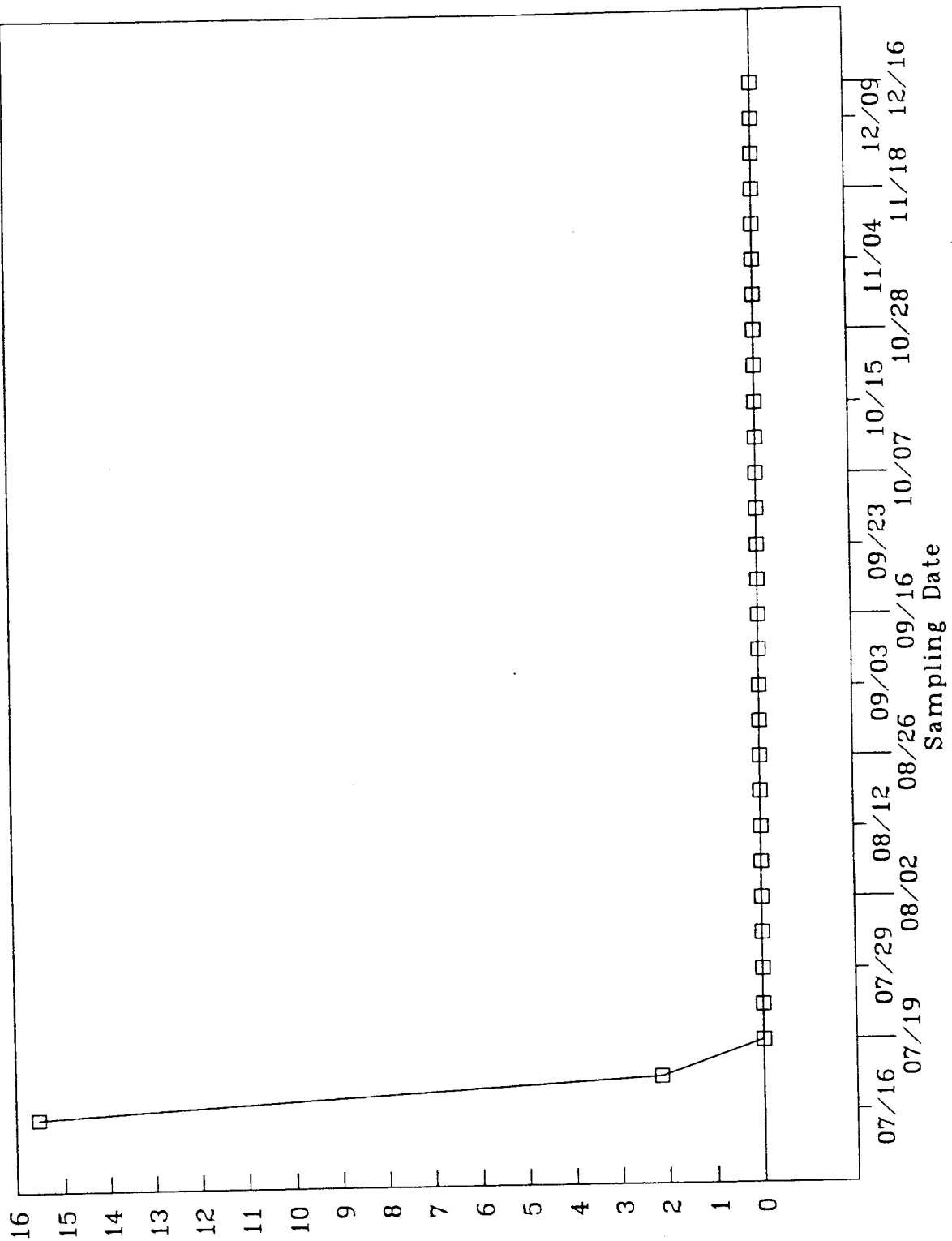


Job No. : 89MC114G1

Prepared by : M.A.G.

Date : 1/21/92

P-7A SHALLOW MONITORING WELLROCKY MOUNTAIN ARSENAL, COLORADO
Figure 4-12



TCE Conc. In Monitoring Well (ppm)

Job No. : 89MC114G1

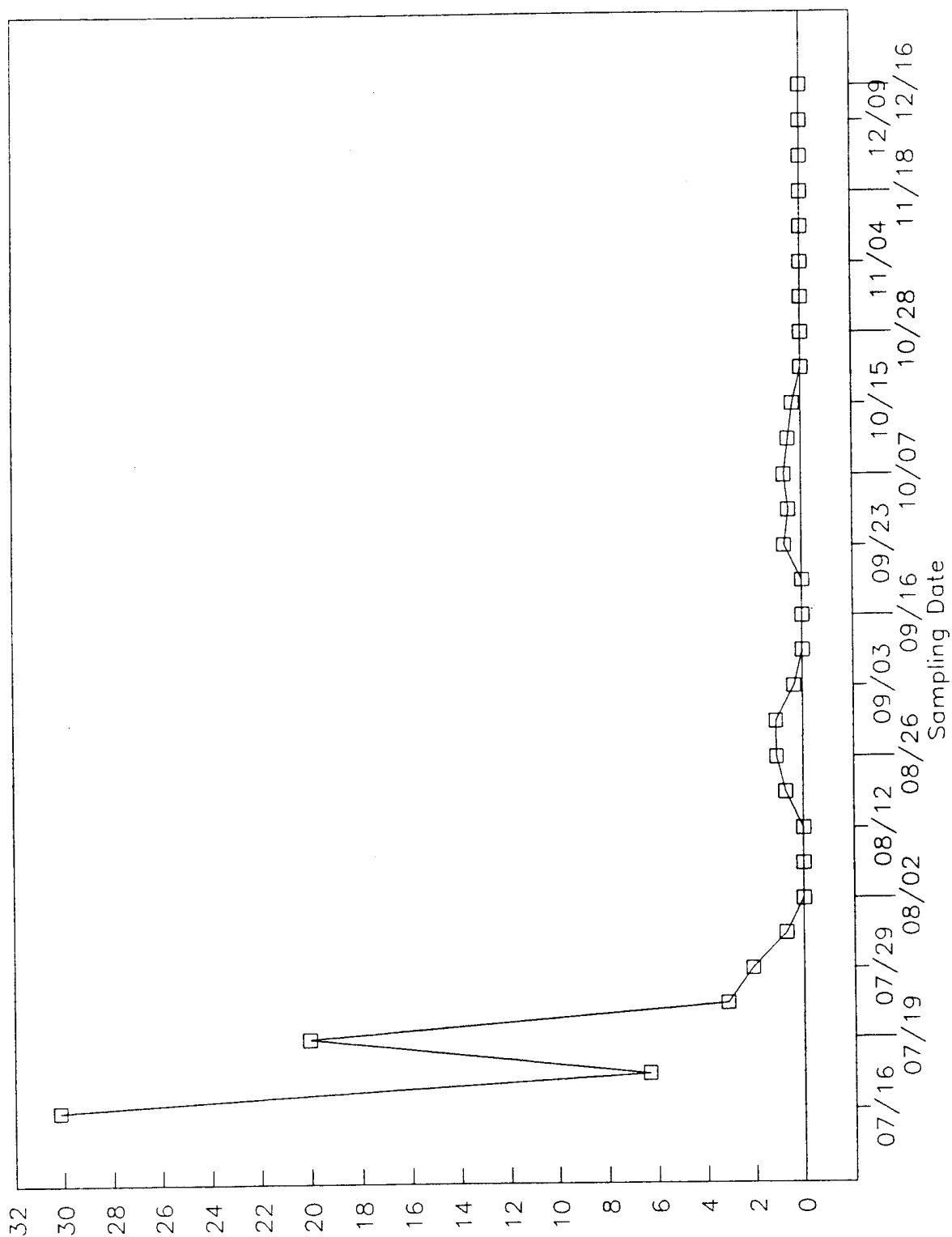
Prepared by : M.A.G.

Date : 1/21/92

P-8A SHALLOW MONITORING WELL

ROCKY MOUNTAIN ARSENAL, COLORADO

Figure 4-13



TCE Conc. in Monitoring Well (ppm)

Job No. : 89MC114G1

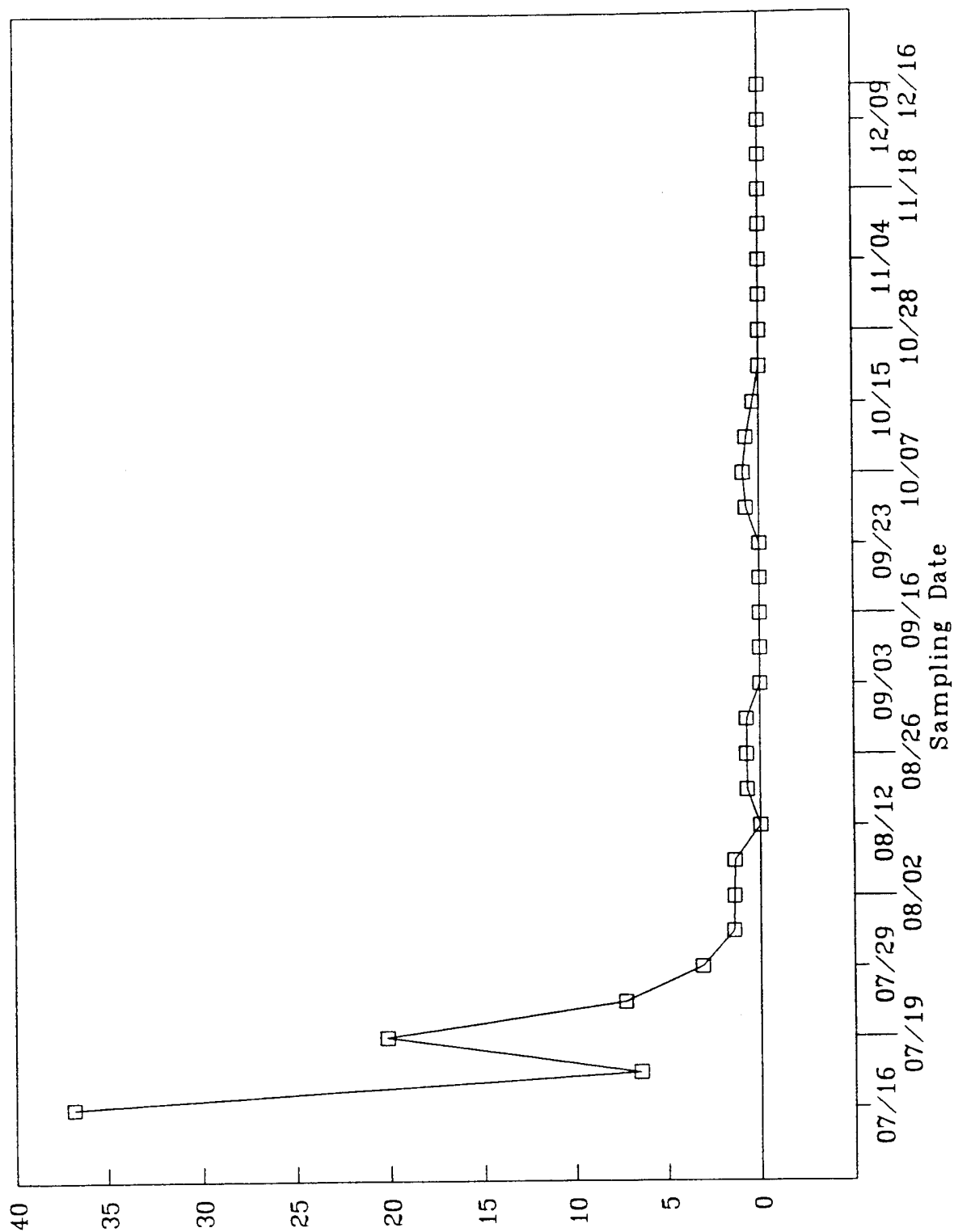
Prepared by : M.A.G.

Date : 1/21/92

P-5B MEDIUM MONITORING WELL

ROCKY MOUNTAIN ARSENAL, COLORADO

Figure 4-14



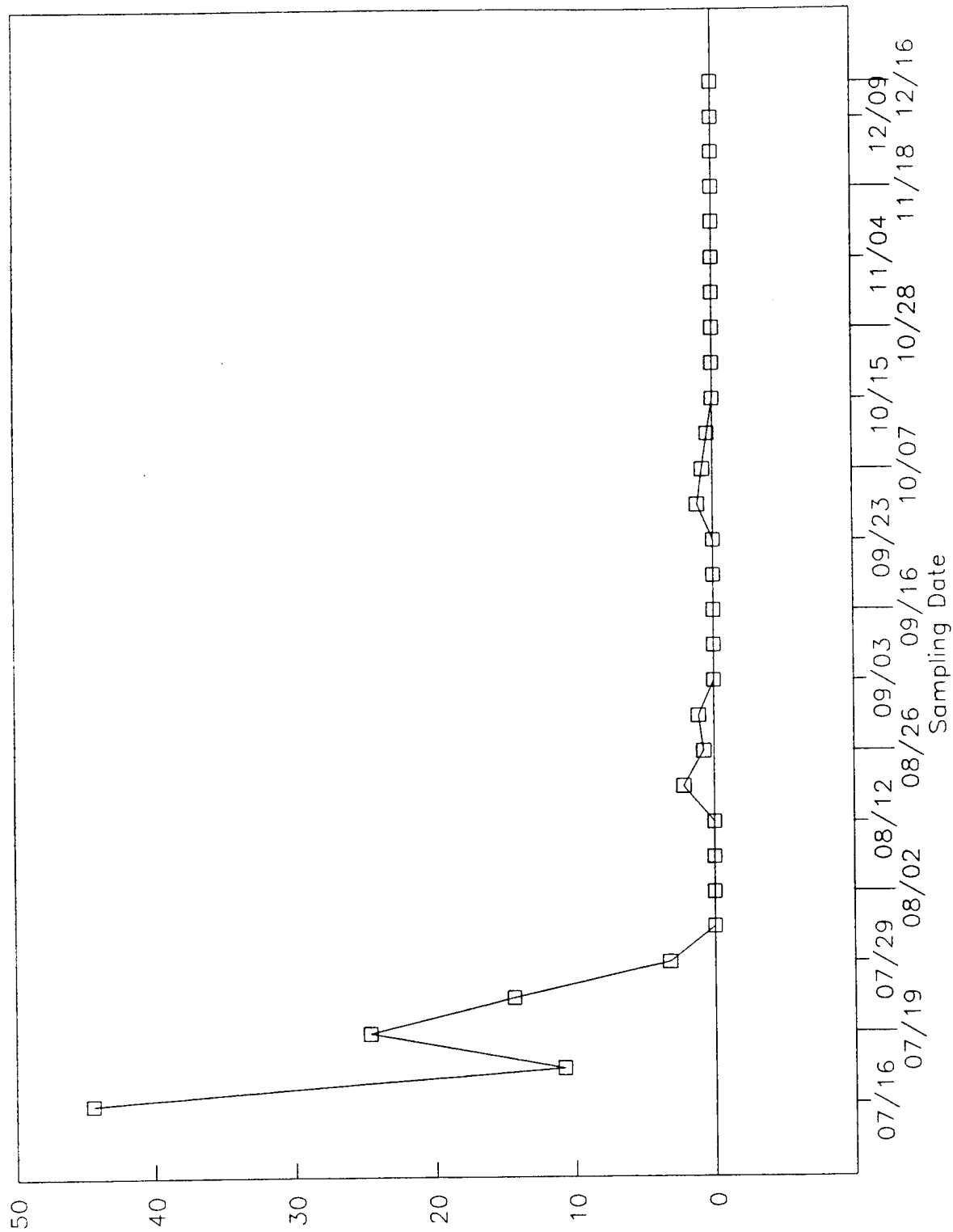
TCE Conc. at Monitoring Well (ppm)

Job No. : 89MC114G1

Prepared by : M.A.G.

Date : 1/21/92

P-6B MEDIUM MONITORING WELLROCKY MOUNTAIN ARSENAL, COLORADO
Figure 4-15



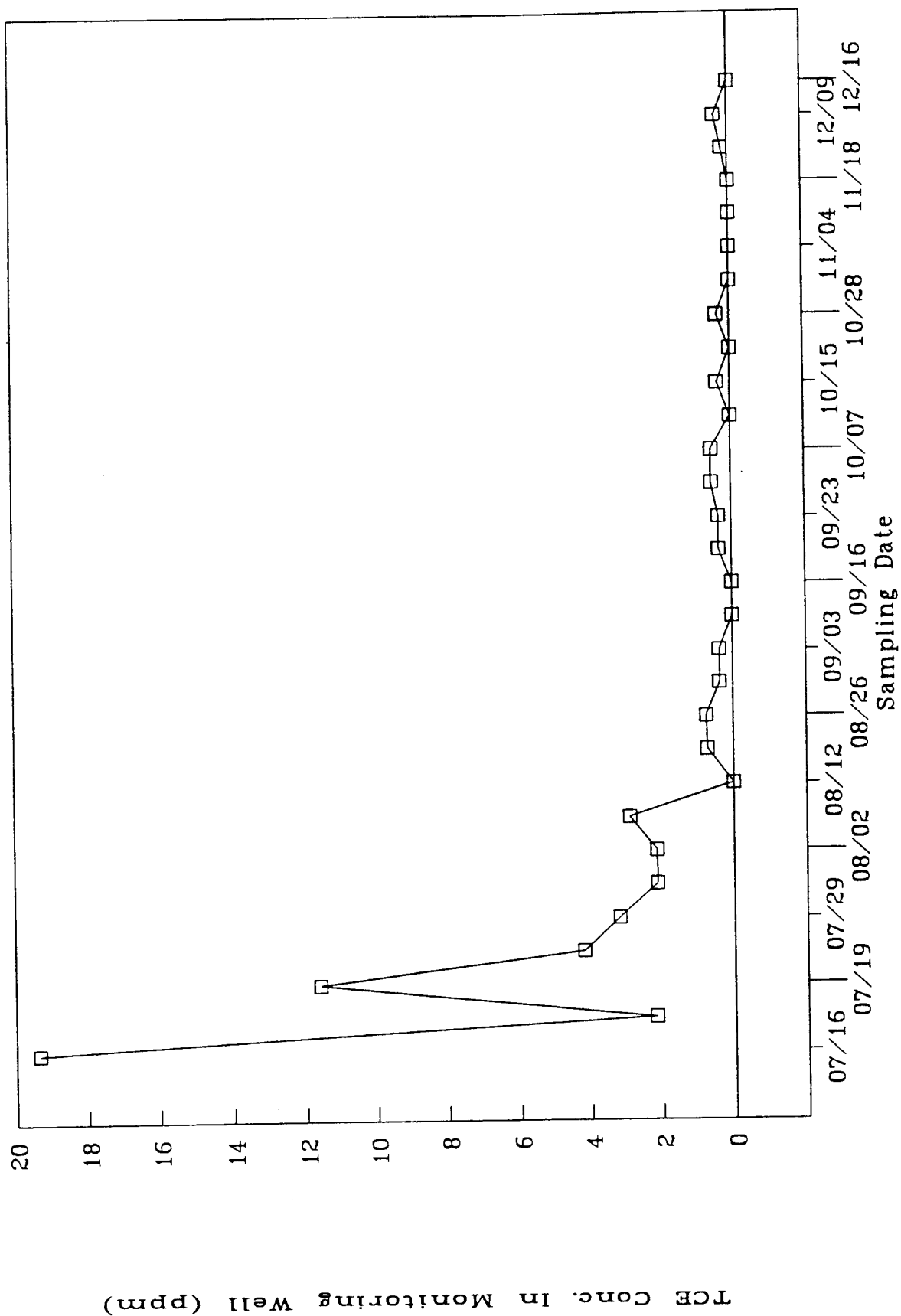
TCE Conc. in Monitoring Well (ppm)

Job No. :	89MC114G1
Prepared by :	M.A.G.
Date :	1/21/92

P-7B MEDIUM MONITORING WELL

ROCKY MOUNTAIN ARSENAL, COLORADO
Figure 4-16



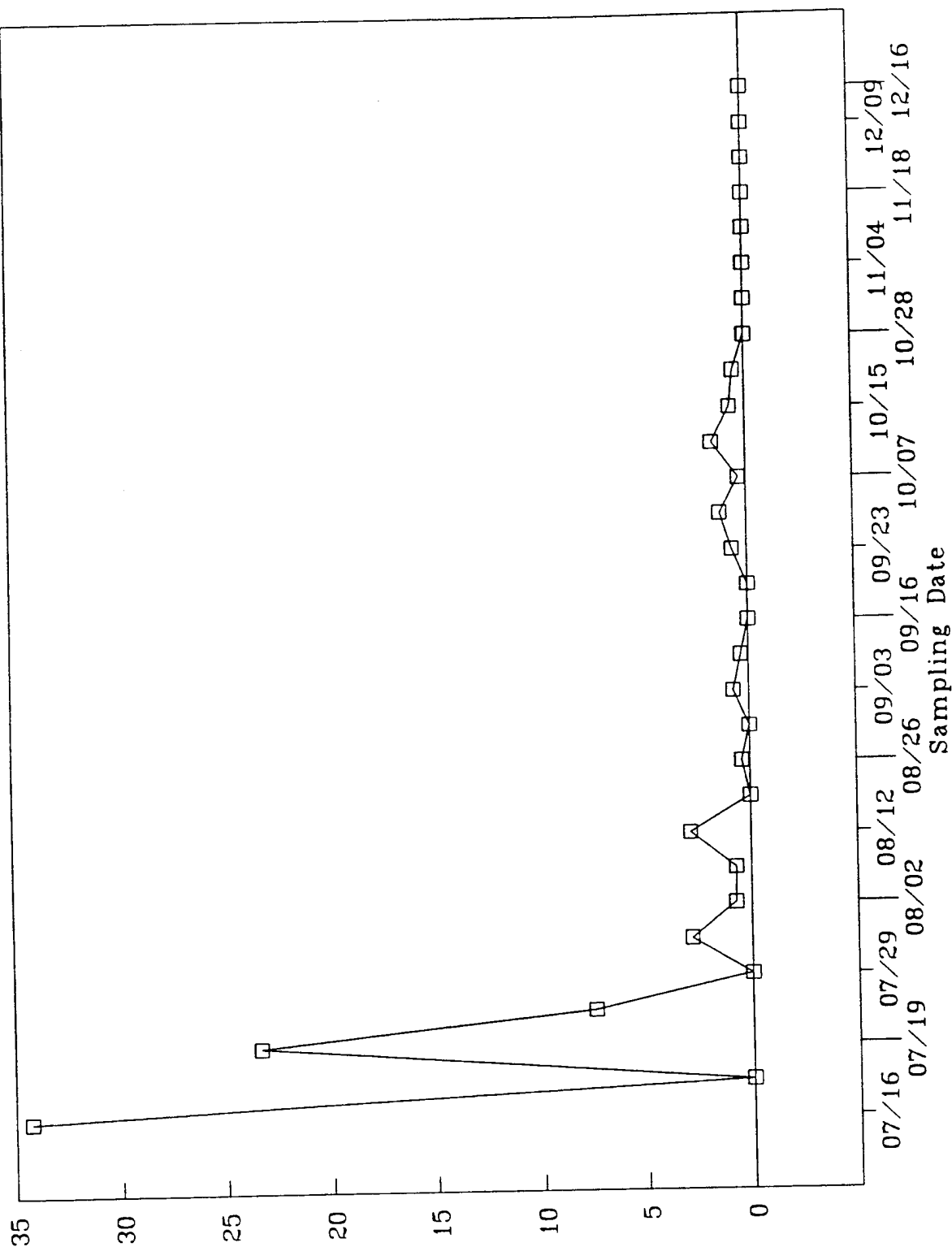


Job No. : 89MC114G1

Prepared by : M.A.G.

Date : 1/21/92

P-8B MEDIUM MONITORING WELL
 ROCKY MOUNTAIN ARSENAL, COLORADO
 Figure 4-17

TCE Conc. at Monitoring Well (ppm)

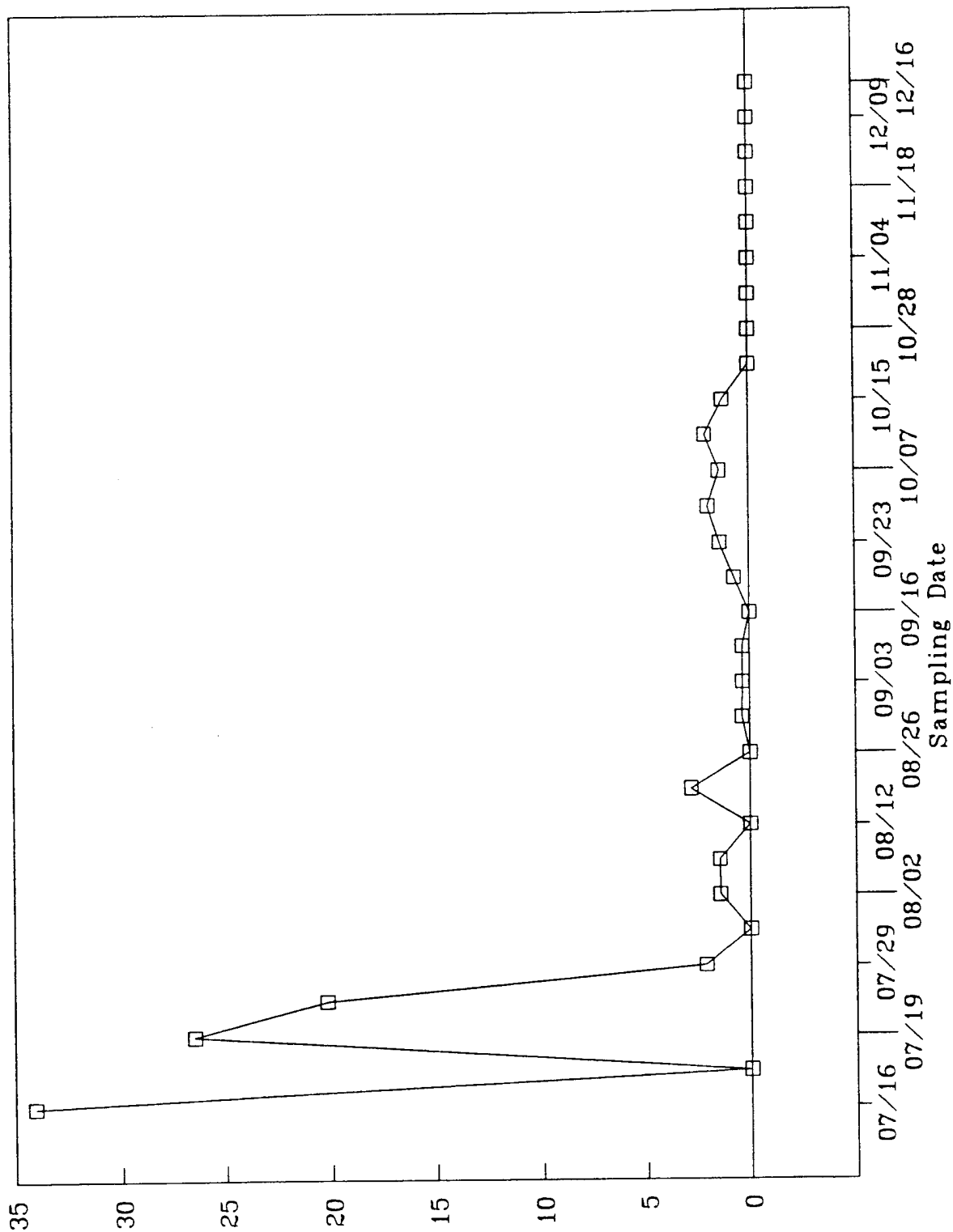
Job No. : 89MC114G1

Prepared by : M.A.G.

Date : 1/21/92

P-5C DEEP MONITORING WELL

ROCKY MOUNTAIN ARSENAL, COLORADO
Figure 4-18



TCE Conc. at Monitoring Well (ppm)

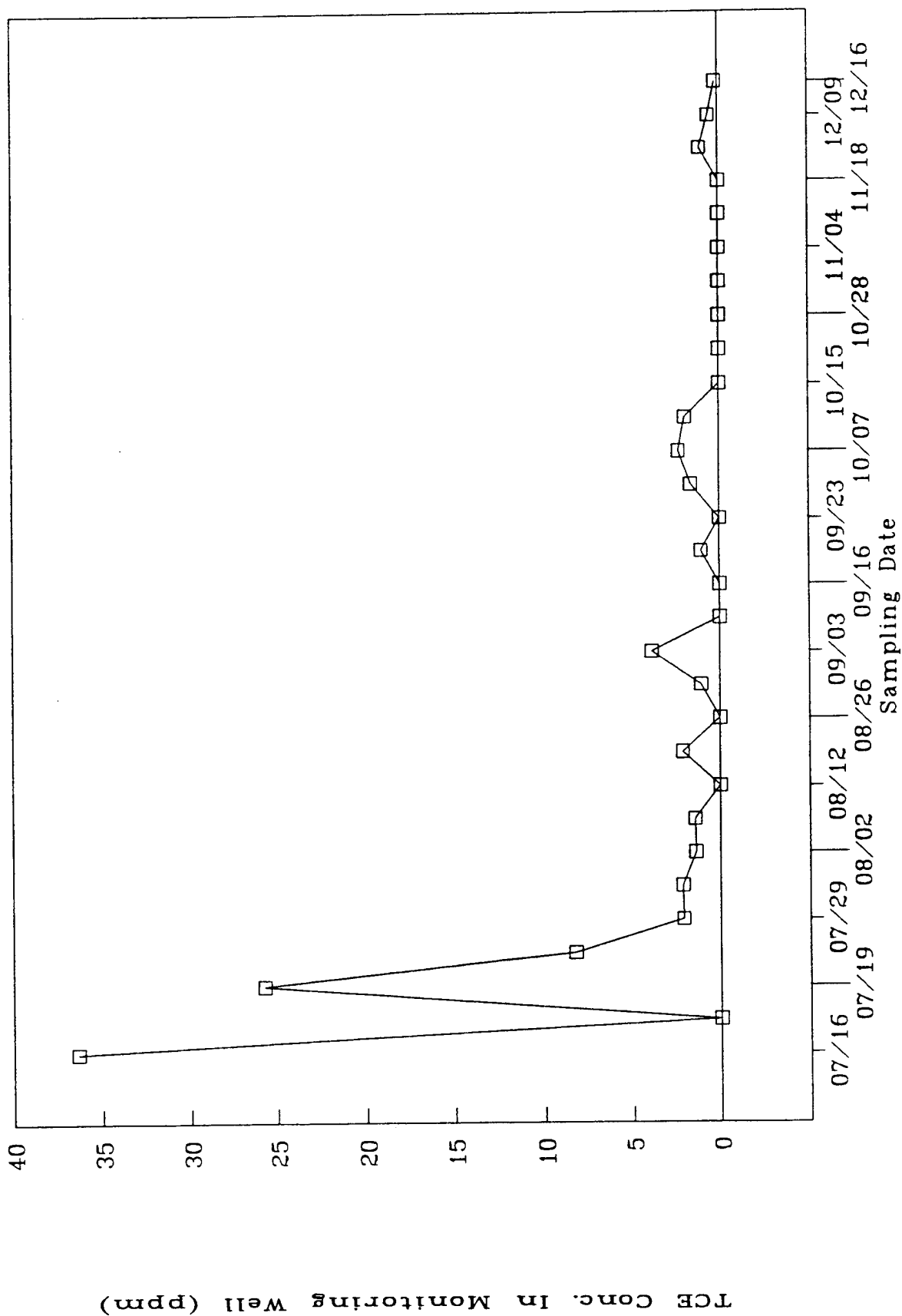
Job No. : 89MC114G1

Prepared by : M.A.G.

Date : 1/21/92

P-6C DEEP MONITORING WELL

ROCKY MOUNTAIN ARSENAL, COLORADO
Figure 4-19



Job No. : 89MC114G1

Prepared by : M.A.G.

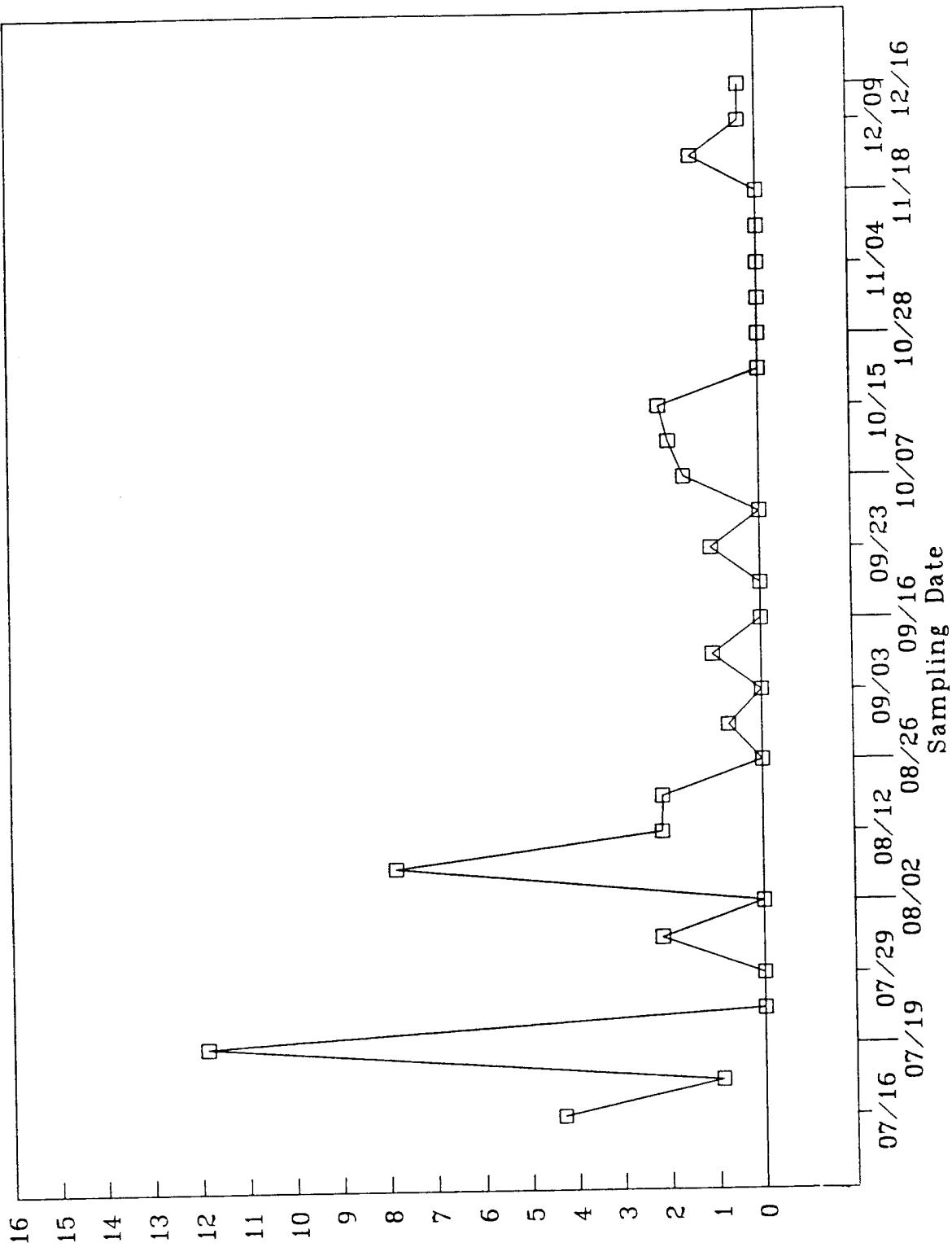
Date : 1/21/92

P-7C DEEP MONITORING WELL

ROCKY MOUNTAIN ARSENAL, COLORADO

Figure 4-20





TCE Conc. In Monitoring Well (ppm)

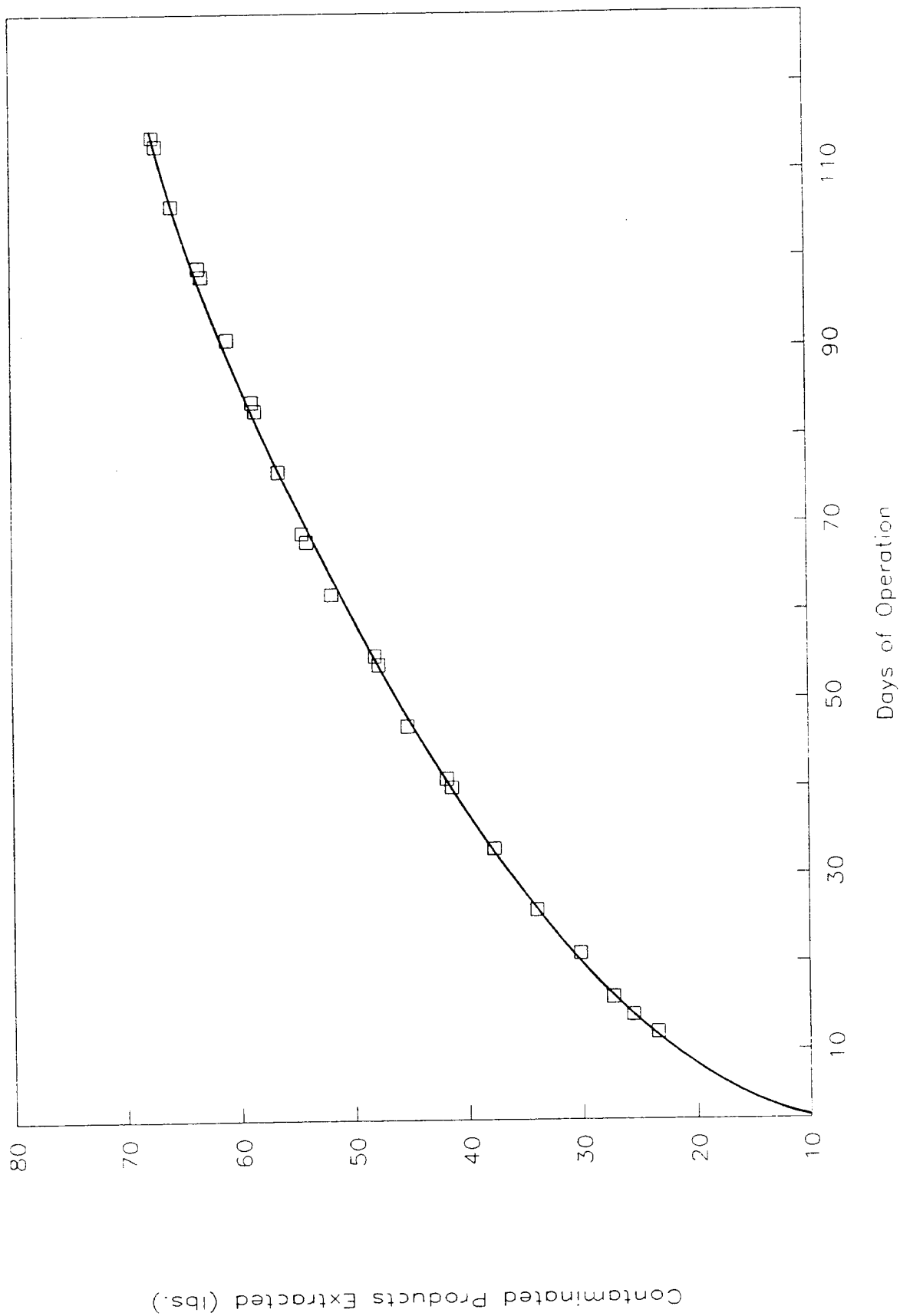
Job No. : 89MC114G1

Prepared by : M.A.G.

Date : 1/21/92

P-8C DEEP MONITORING WELL

ROCKY MOUNTAIN ARSENAL, COLORADO
Figure 4-21



Job No. :	89MC114G1
Prepared by :	M.A.G.
Date :	1/21/92

TOTAL MASS TCE EXTRACTED
ROCKY MOUNTAIN ARSENAL, COLORADO
Figure 4-22



CONCLUSIONS

Based on the pilot study testing conducted at the Rocky Mountain Arsenal Motor Pool Area, the following can be concluded:

- SVE was an effective remediation technique for removing TCE from the permeable soils found at this site.
- The majority of the TCE contamination was extracted from the shallow and medium regions, which suggests that the clay lens served as a partial vapor barrier to downward migration of TCE. Lower concentrations extracted from the deeper region suggest that re-volatilization of TCE from the groundwater was not a major contribution to the overall mass of TCE removed. It can be concluded the optimum extraction interval was the shallow well.
- Initial observed concentrations of TCE in the soil gas monitoring wells did not exhibit appreciable spacial variations. No conclusions were drawn with respect to horizontal distribution of TCE and potential source areas.
- Based on the vacuum induced in the remote soil gas monitoring probes when extracting from the shallow well, short-circuiting of atmospheric air was not significant, thereby precluding the need for a surface seal.
- TCE concentrations in the soil gas monitoring wells and blower exhaust decreased to non-detectable or low levels over the duration of this pilot study. It can be concluded that soil within the radial influence of the extraction wells (suspected source area) was remediated of TCE and no further extraction is required.

REFERENCES

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- Freeze, R.A. and Cherry, J.A., Groundwater, 1st Ed., Prentice-Hall, Inc., Englewood Cliffs, NJ, 1979.
- Woodward-Clyde Consultants. February 1990. Final Decision Document for the Interim Response Action at the Motor Pool Area Rocky Mountain Arsenal, Version 4.0. RIC 900072R04.
- Woodward-Clyde Consultants. January 1991. Final Results of Field and Laboratory Investigations Conducted to Evaluate Interim Response Actions for Other Contamination Sources, Version 3.0. RIC 91002R05.

Woodward-Clyde Consultants. February 1991a. Implementation Document for the Interim Response Action at the Motor Pool Area, Rocky Mountain Arsenal, Final Version 3.1 RIC #91052R01.

APPENDIX A
WELL CONSTRUCTION DETAILS

GROUNDWATER MONITORING WELL AND PIEZOMETER REPORT

PROJECT <u>RMACOE MOTOR POOL VES 89M114G1</u>		Page <u>1</u> of <u>1</u>
LOCATION <u>SECTION 4 (9948 WCF5)</u>		Well No. <u>VES-3</u>
Date Completed <u>6/6/91</u>	Original Depth <u>30'</u>	Aquifer <u>NA</u>
Inspected By <u>H. MERRELL</u>	Date _____	SCREEN Depth Interval <u>28'-13'</u>
Checked By _____	Date _____	

Elevation of top of surface casing / riser pipe.	_____
Height of top of surface casing / riser pipe above ground surface	<u>20"</u>
Depth of surface seal below ground surface	<u>2'</u>
Type of surface seal: <u>CONCRETE</u>	_____
I.D. of surface casing.	_____
Type of surface casing: _____	_____
Depth of surface casing below ground	_____
O.D. of riser pipe.	<u>4"</u>
Type of riser pipe: <u>PVC Sched 40</u>	_____
Diameter of borehole	<u>10 1/2"</u>
Depth of borehole	<u>30'</u>
Type of backfill: <u>GROUT</u>	_____
Elev./depth top of seal.	<u>5 1/2</u>
Type of seal: <u>BENTONITE CHIPS</u>	<u>11'</u>
Elev./depth bottom of seal.	_____
Type of sand pack: <u>20-40 SILICA</u>	<u>11'</u>
Depth of top of sand pack.	<u>13'</u>
Elev./depth top of screened section.	_____
Type of screened section: <u>Sched 40 PVC</u>	_____
Describe openings: <u>0.20" FACTORY SLOTTED</u>	_____
O.D. of screened section.	<u>1"</u>
Elev./depth bottom of screened section.	<u>28'</u>
Elev./depth bottom of sand column.	<u>30'</u>
Type of backfill below observation pipe: <u>20-40 SILICA SAND</u>	_____
Elev./depth of hole.	<u>30'</u>

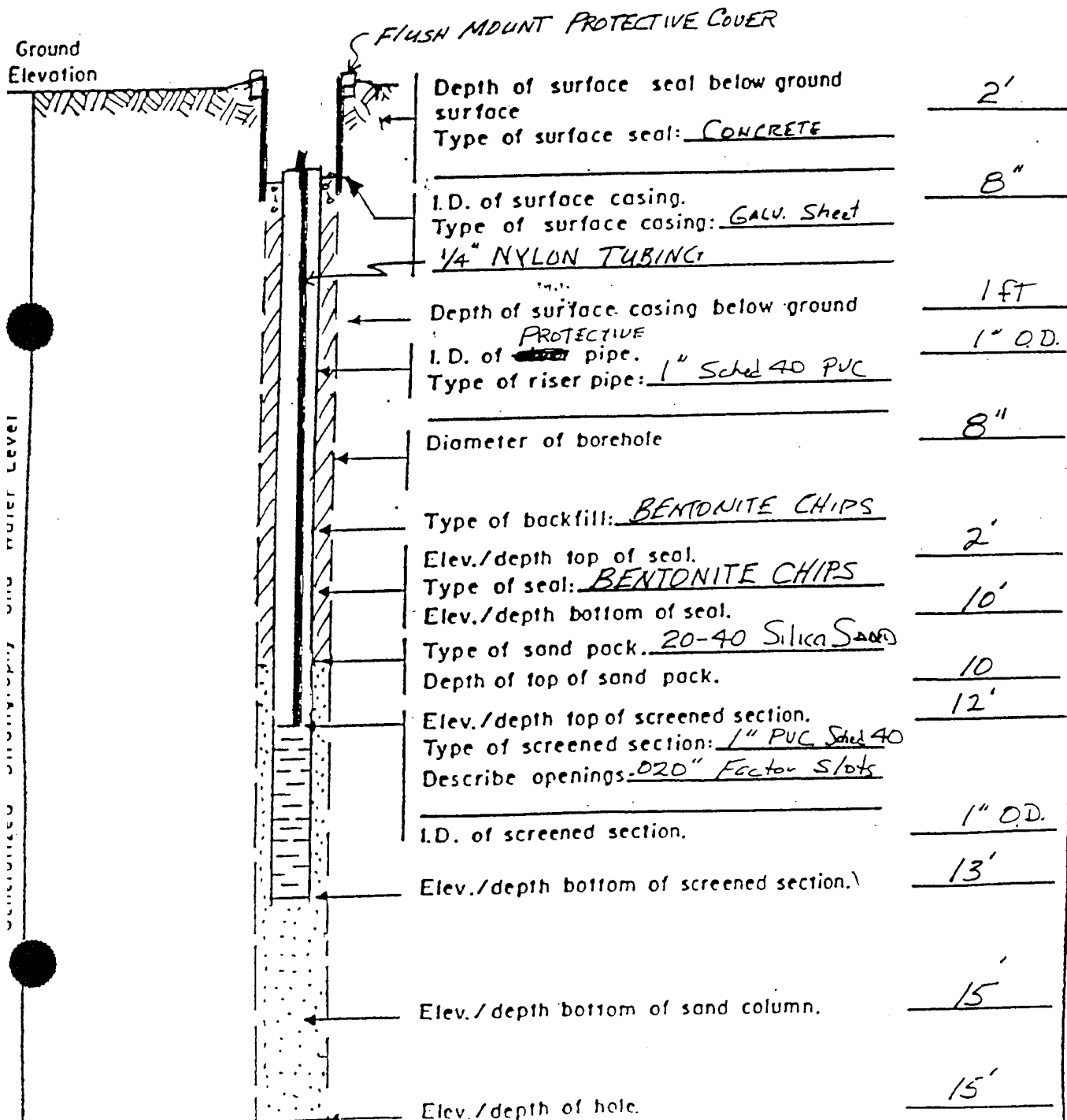
GROUNDWATER MONITORING WELL AND PIEZOMETER REPORT

PROJECT <u>RMACOE MOTOR POOL VES 89M114G1</u>		Page <u>1</u> of <u>1</u>
LOCATION <u>Section 4 (9948 WCF5)</u>		Well No. <u>VES-4</u>
Date Completed <u>6/7/91</u> Original Depth <u>60'</u>		Aquifer <u>NA</u>
Inspected By <u>H. MERRELL</u> Date _____		SCREEN Depth Interval <u>58-43</u>
Checked By _____ Date _____		

Elevation of top of surface casing / riser pipe.		
Height of top of surface casing / riser pipe above ground surface.		<u>20"</u>
Depth of surface seal below ground surface		<u>2</u>
Type of surface seal: <u>CONCRETE</u>		
I.D. of surface casing.		<u>—</u>
Type of surface casing: _____		
Depth of surface casing below ground		<u>—</u>
O.D. of riser pipe.		<u>4"</u>
Type of riser pipe: <u>PVC Sched 40</u>		
Diameter of borehole		<u>10 1/2"</u>
Depth of borehole		<u>60'</u>
Type of backfill: <u>GROUT</u>		
Elev./depth top of seal.		<u>35</u>
Type of seal: <u>BENTONITE CHIPS</u>		
Elev./depth bottom of seal.		<u>40</u>
Type of sand pack: <u>20-40 Silica</u>		
Depth of top of sand pack.		<u>40</u>
Elev./depth top of screened section.		<u>43</u>
Type of screened section: <u>Sched 40 PVC</u>		
Describe openings: <u>0.20" FACTORY SLOTTED</u>		
O.D. of screened section.		<u>1"</u>
Elev./depth bottom of screened section.		<u>58'</u>
Elev./depth bottom of sand column		<u>60</u>
Type of backfill below observation pipe: <u>20-40 Silica Sand</u>		
Elev./depth of hole.		<u>60</u>

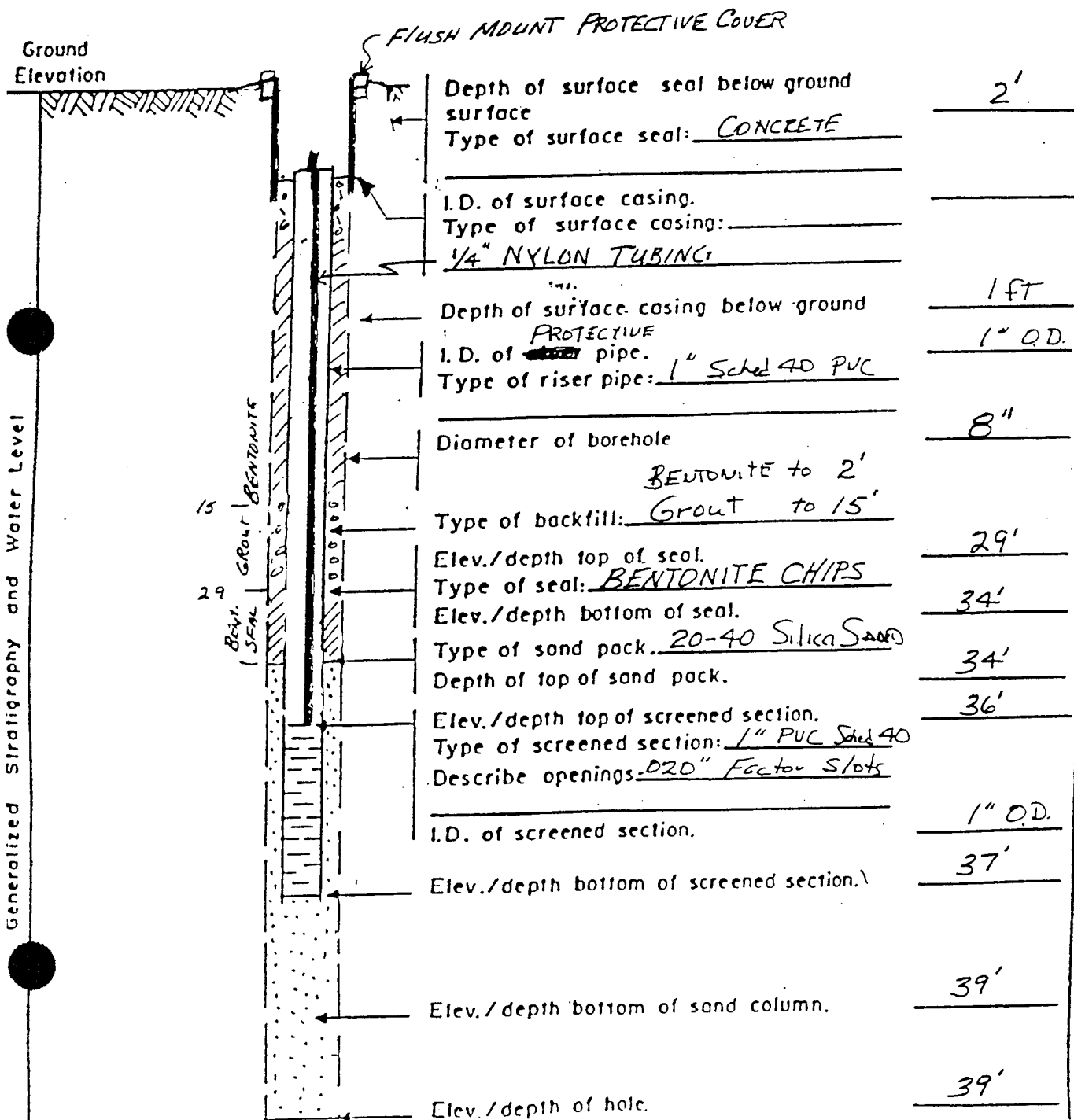
OBSERVATION WELL REPORT

OBJECT <u>RMACOE MOTOR POOL VES</u> <u>89 M 11461</u> LOCATION <u>SECTION 4</u> <u>(9948 WCFS)</u> Date Completed <u>6/11/91</u> Original Depth <u>15'</u> Inspected By <u>H. MERRELL</u> Date <u>6/11/91</u> Checked By _____ Date _____	Page <u>1</u> of <u>1</u> Well No. <u>VESP-5A</u> SCREEN Depth Interval <u>12'-13'</u>
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OBSERVATION WELL REPORT

OBJECT <u>RMACOE MOTOR POOL VES</u> <u>89M11461</u> LOCATION <u>SECTION 4</u> <u>(9948 WCFs)</u> Date Completed <u>6/10/91</u> Original Depth <u>39'</u> Inspected By <u>H. MERRELL</u> Date _____ Checked By <u>6/10/91</u> Date _____	Page <u>1</u> of <u>1</u> Well No. <u>VESP-5B</u> SCREEN Depth Interval <u>37'-36'</u>
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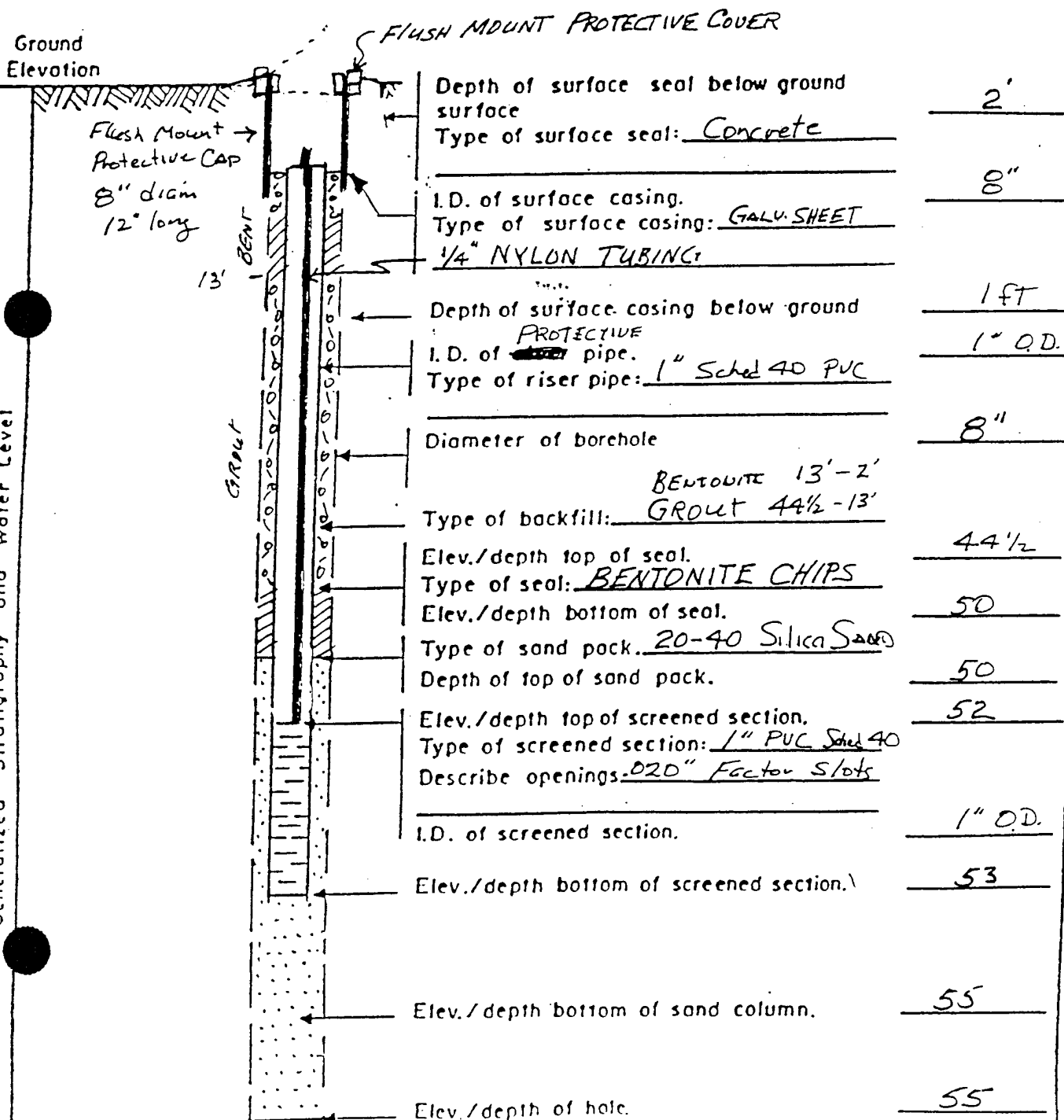


OBSERVATION WELL REPORT

PROJECT RMACOE MOTOR POOL VES 89M 114 G1
 LOCATION SECTION 4 (9948 WCFs)
 Date Completed _____ Original Depth 55
 Inspected By H. MERRELL Date _____
 Checked By _____ Date _____

Page 1 of 1
 Well No. VESP-5C

SCREEN
 Depth Interval 52'-53'

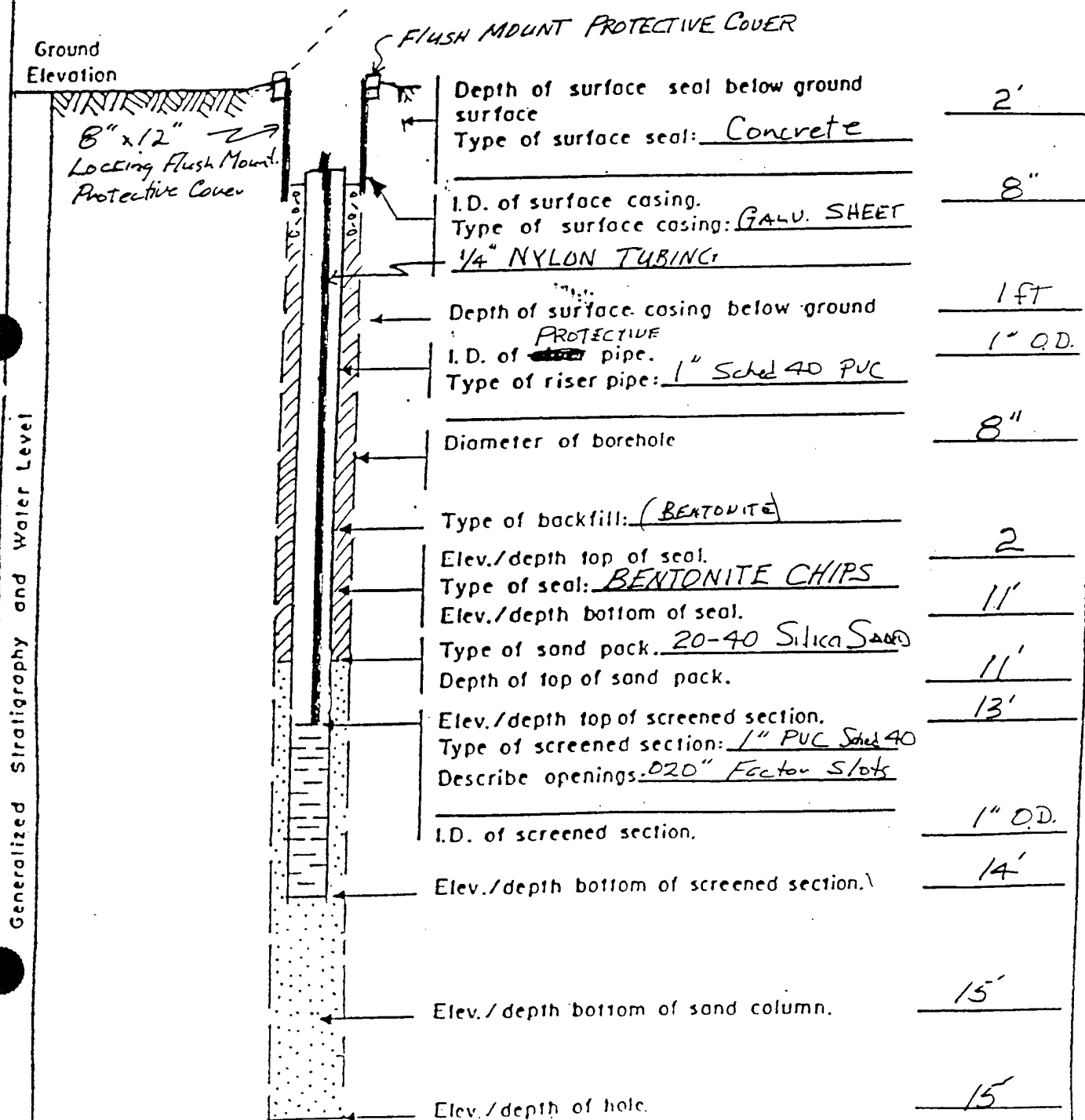


OBSERVATION WELL REPORT

PROJECT RMACOE MOTOR POOL VES 89M114G1
 LOCATION SECTION 4 (9948 WCF5)
 Date Completed 6/13/91 Original Depth _____
 Inspected By H. MERRELL Date _____
 Checked By _____ Date _____

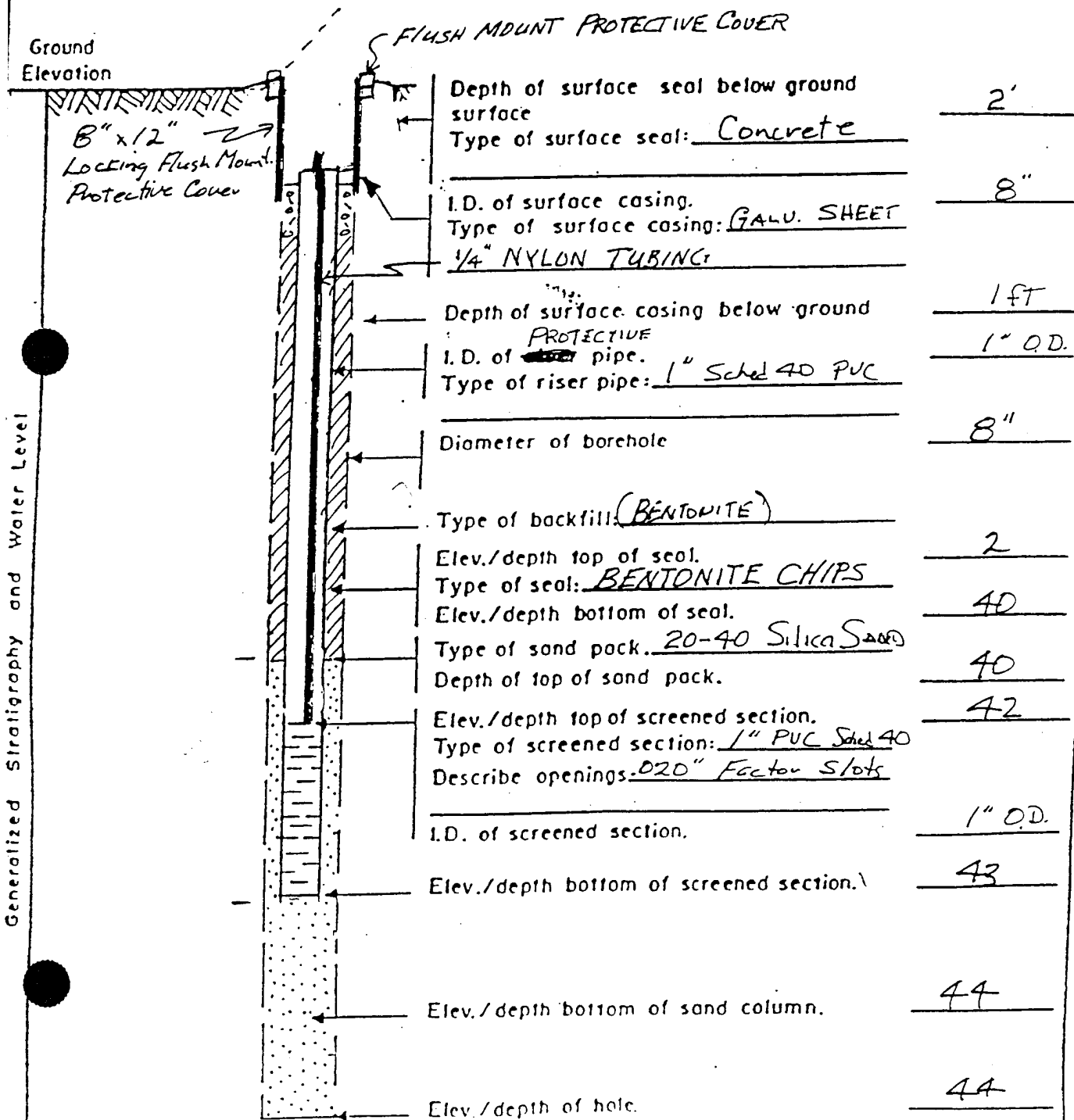
Page 1 of 1
 Well No. VESP-6A

SCREEN
 Depth Interval 13'-14'



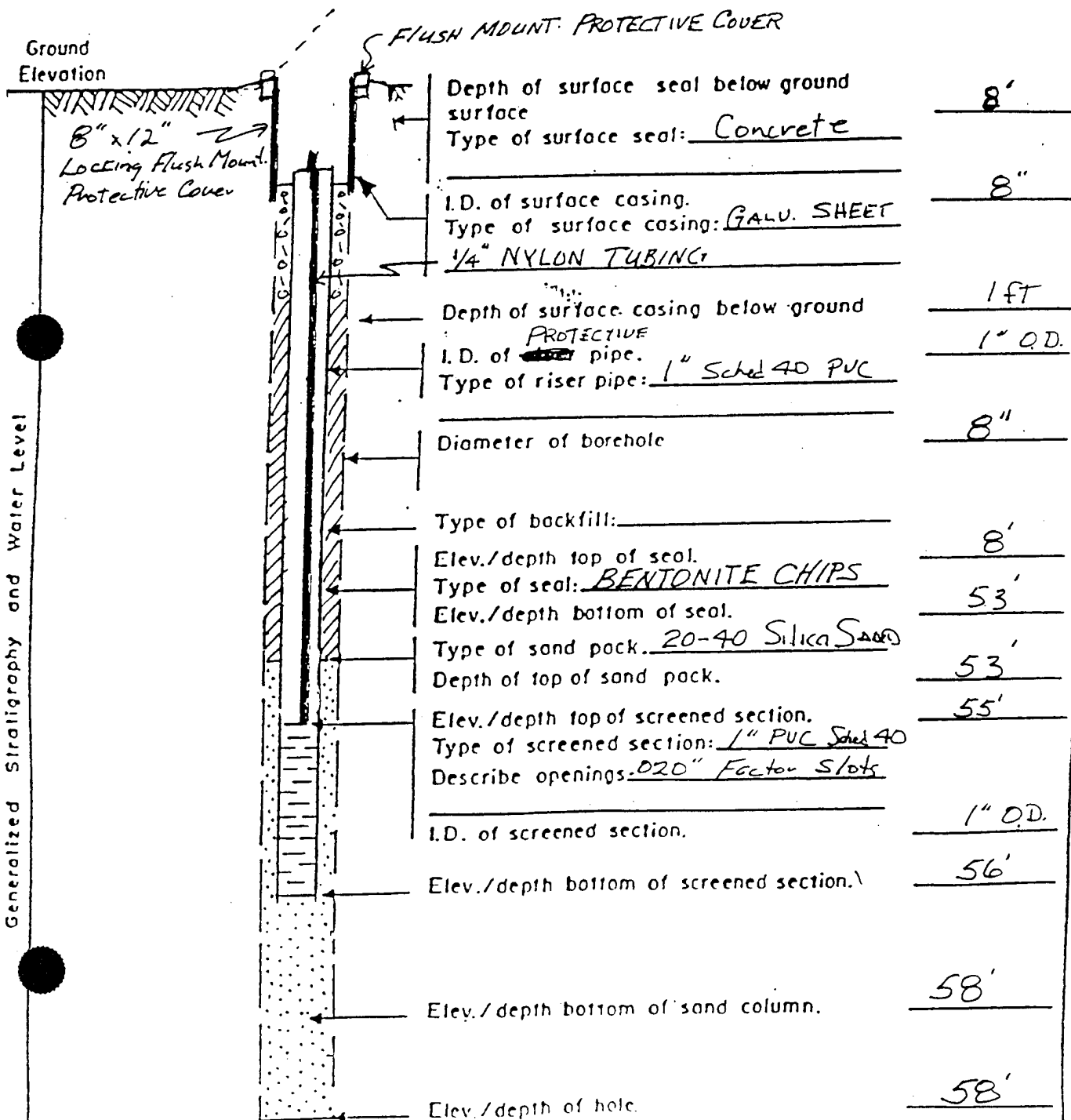
OBSERVATION WELL REPORT

PROJECT <u>RMACOE MOTOR POOL VES</u>	<u>89M114G1</u>	Page <u>1</u> of <u>1</u>
LOCATION <u>SECTION 4</u>	<u>(9948 WCF5)</u>	Well No. <u>VESP-63</u>
Date Completed <u>6/13/91</u>	Original Depth <u>44</u>	
Inspected By <u>H. MERRELL</u>	Date _____	
Checked By _____	Date _____	
		SCREEN Depth Interval <u>42'-43'</u>



OBSERVATION WELL REPORT

PROJECT <u>RMACOE MOTOR POOL VES</u> <u>89M114G1</u> LOCATION <u>SECTION 4</u> <u>(9948 WCF)</u> Date Completed <u>6/12/91</u> Original Depth <u>58'</u> Inspected By <u>H. MERRELL</u> Date _____ Checked By _____ Date _____	Page <u>1</u> of <u>1</u> Well No. <u>VESP-6C</u> SCREEN Depth Interval <u>55'-56'</u>
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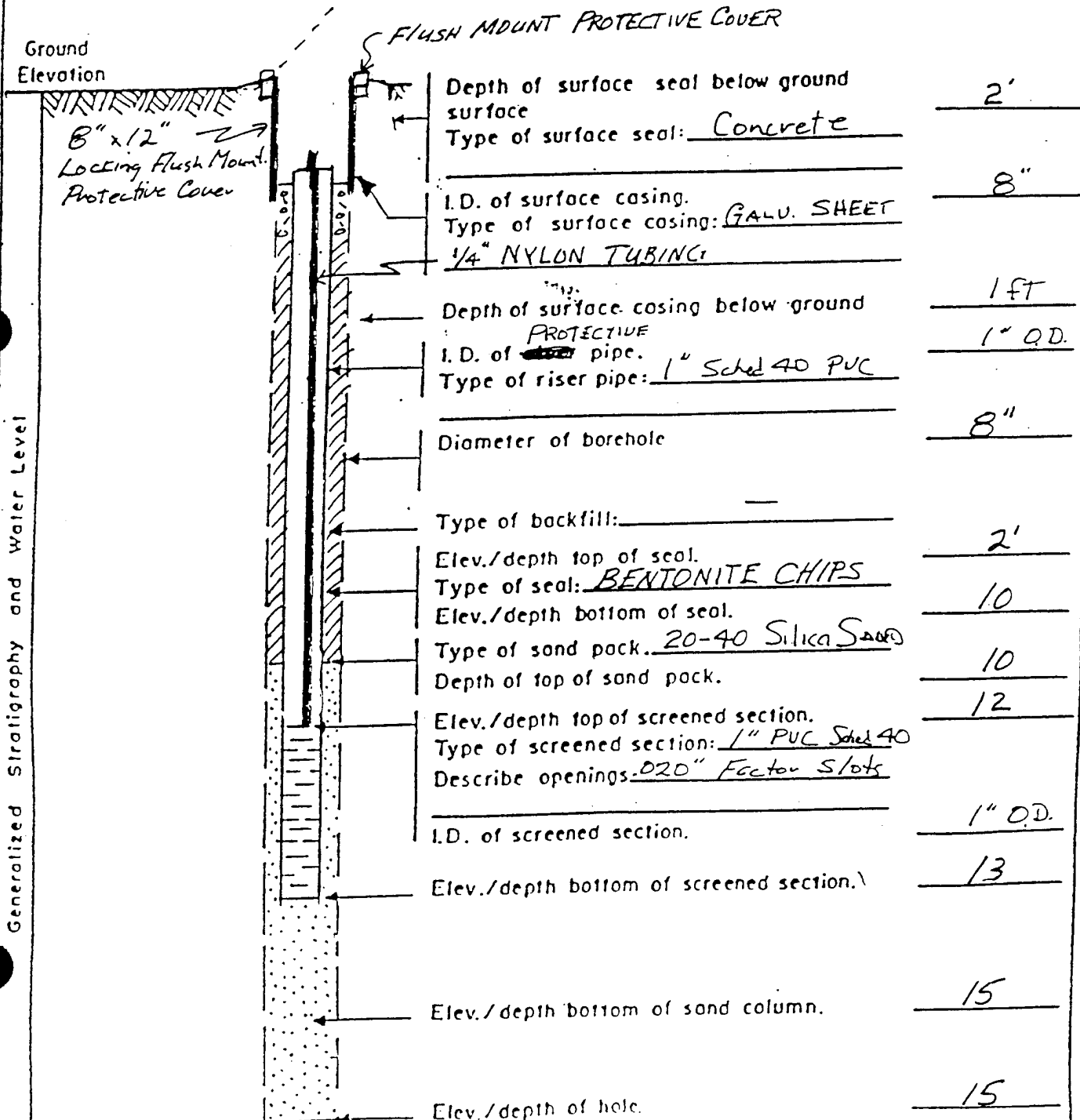


OBSERVATION WELL REPORT

PROJECT RMACOE MOTOR POOL VES 89M114G1
 LOCATION SECTION 4 (9948 WCF5)
 Date Completed 6/12/91 Original Depth 15
 Inspected By H. MERRELL Date _____
 Checked By _____ Date _____

Page 1 of 1
 Well No. VESP-7A

SCREEN
 Depth Interval 13'-14'

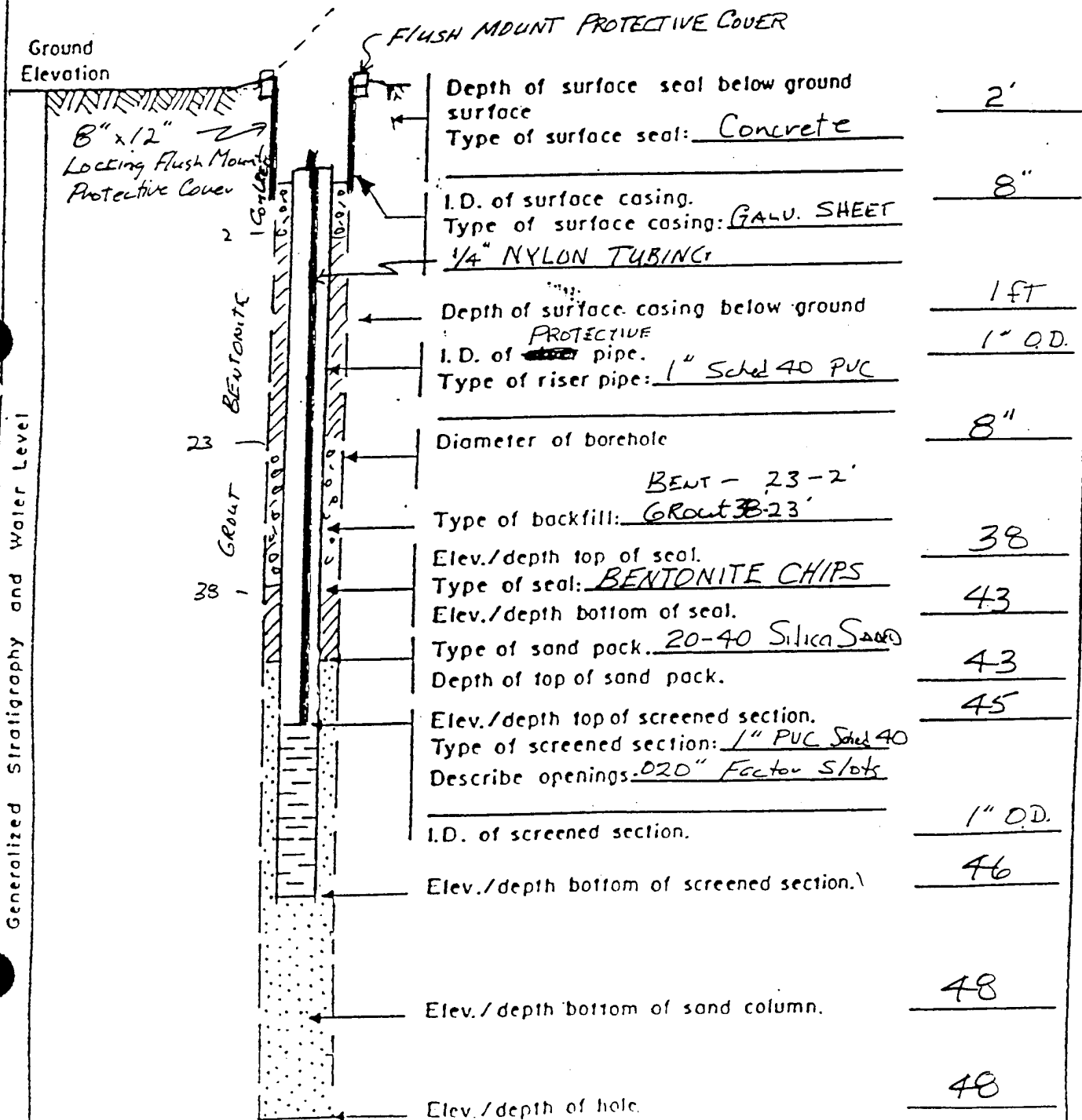


OBSERVATION WELL REPORT

PROJECT RMACOE MOTOR POOL VES 89M114G1
 LOCATION SECTION 4 (9948 WLF5)
 Date Completed 6/11/91 Original Depth 48
 Inspected By H. MERRELL Date _____
 Checked By _____ Date _____

Page 1 of 1
 Well No. VESP-7B

SCREEN
 Depth Interval 45'-46'

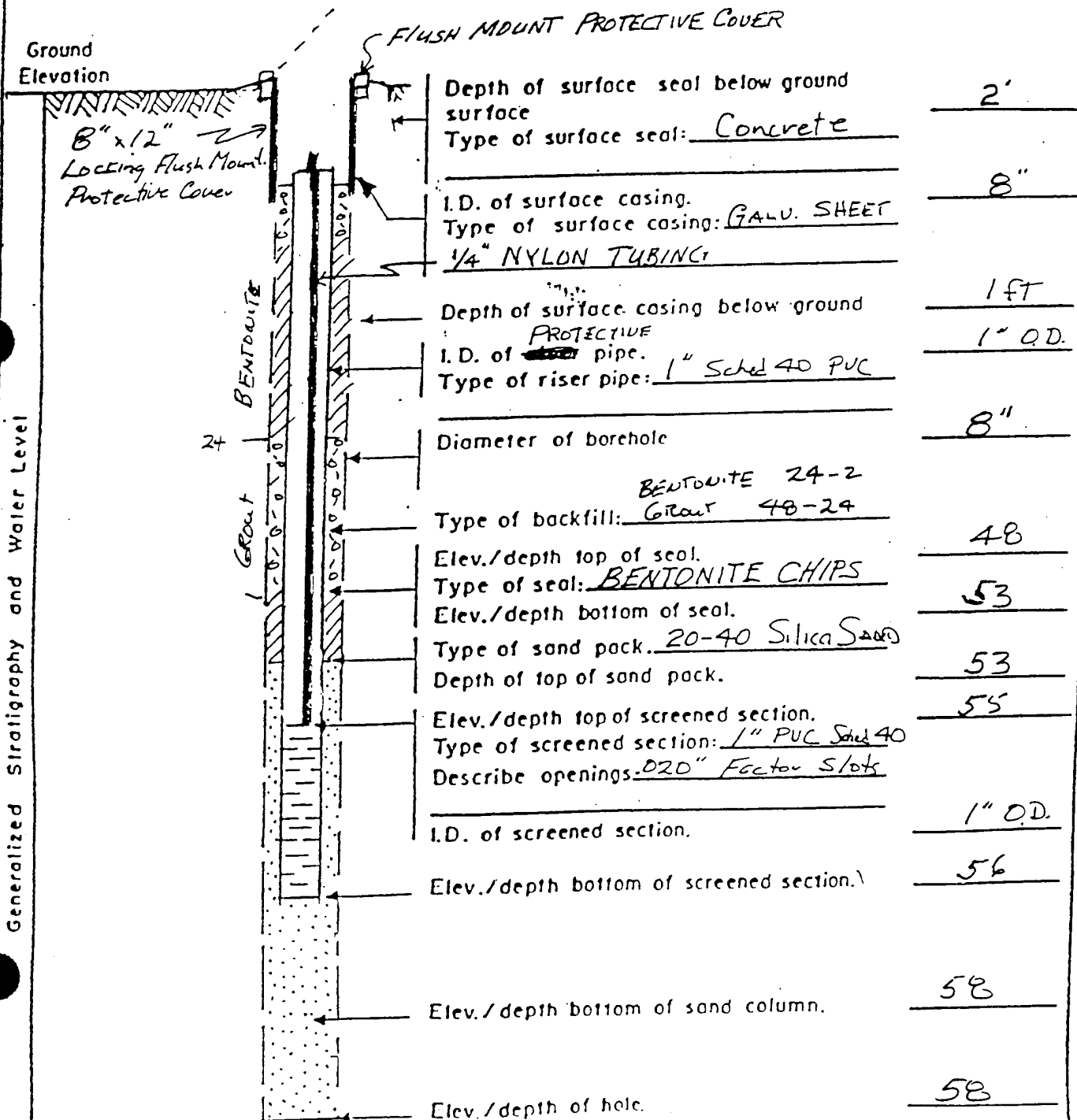


OBSERVATION WELL REPORT

PROJECT RMACOE MOTOR POOL VES 89M114G1
 LOCATION SECTION 4 (9948 WCF5)
 Date Completed 6/11/91 Original Depth 58
 Inspected By H. MERRELL Date _____
 Checked By _____ Date _____

Page 1 of 1
 Well No. VESP-7C

SCREEN
 Depth Interval 56'-53'

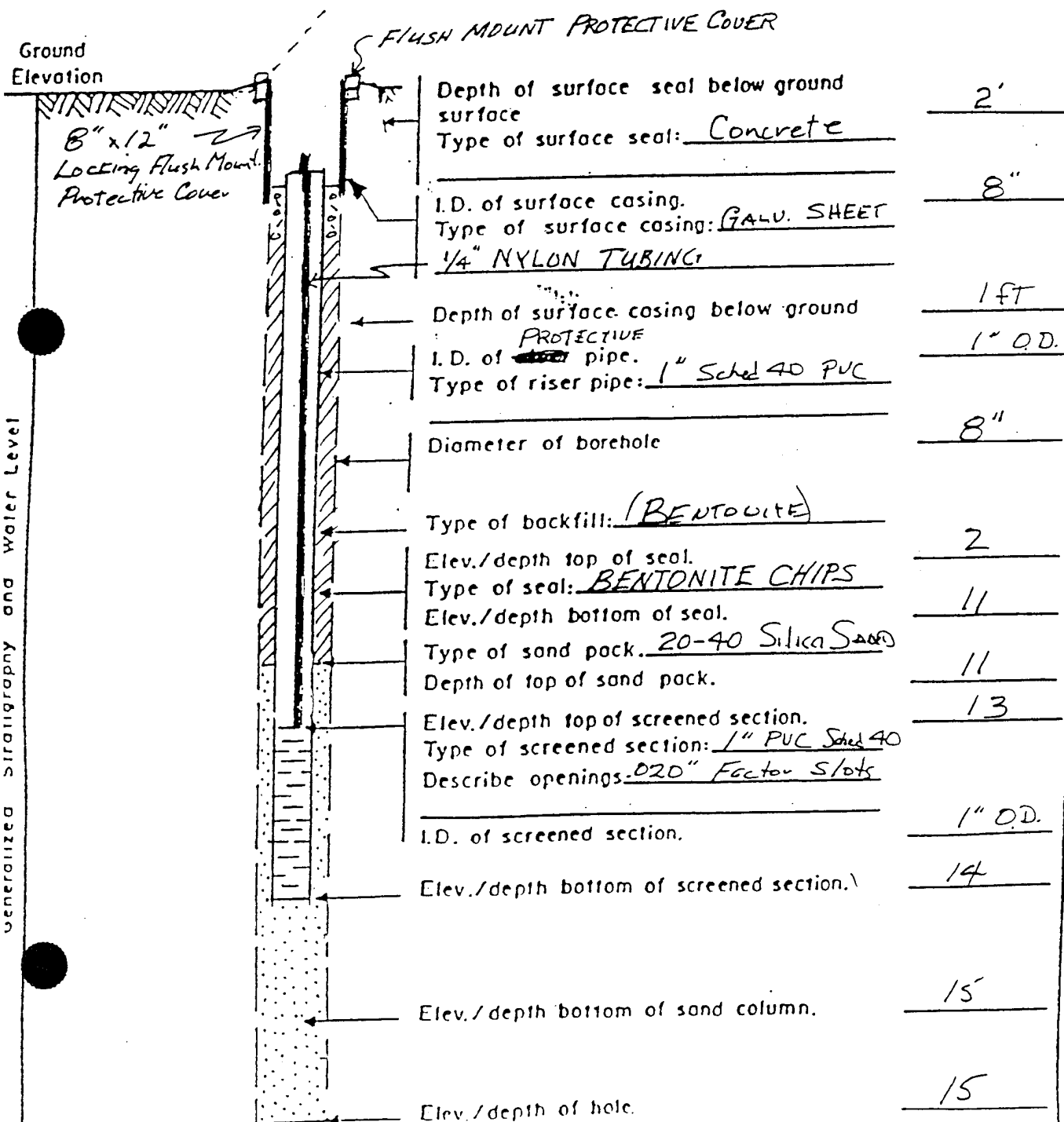


OBSERVATION WELL REPORT

OBJECT RMACOE MOTOR POOL YES 89M11461
 LOCATION SECTION 4 (9948) WCFB
 Date Completed 6/13/91 Original Depth 15
 Inspected By H. MERRELL Date _____
 Checked By _____ Date _____

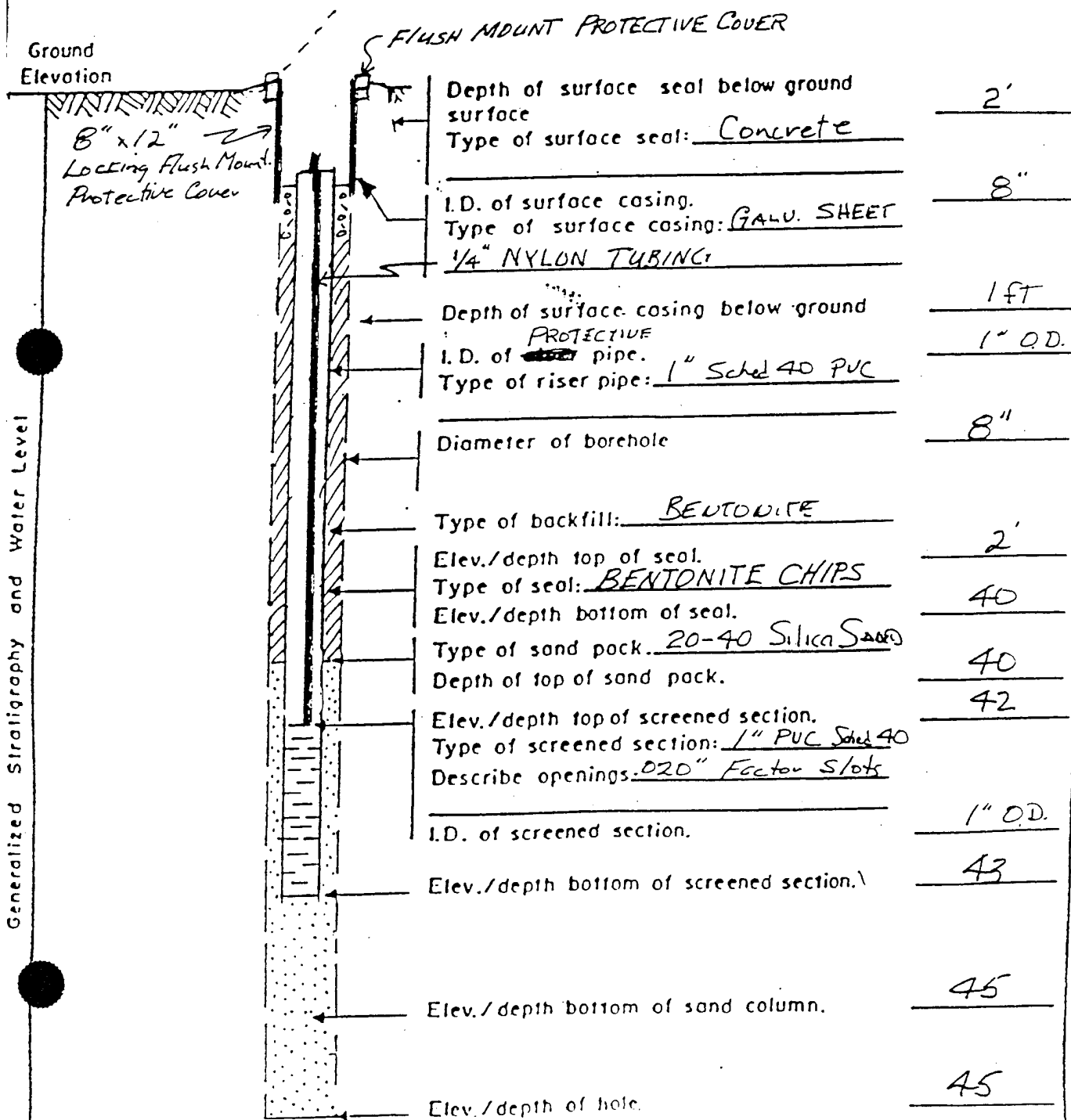
Page 1 of 1
 Well No. VESP-8A

SCREEN
 Depth Interval 13'-14'



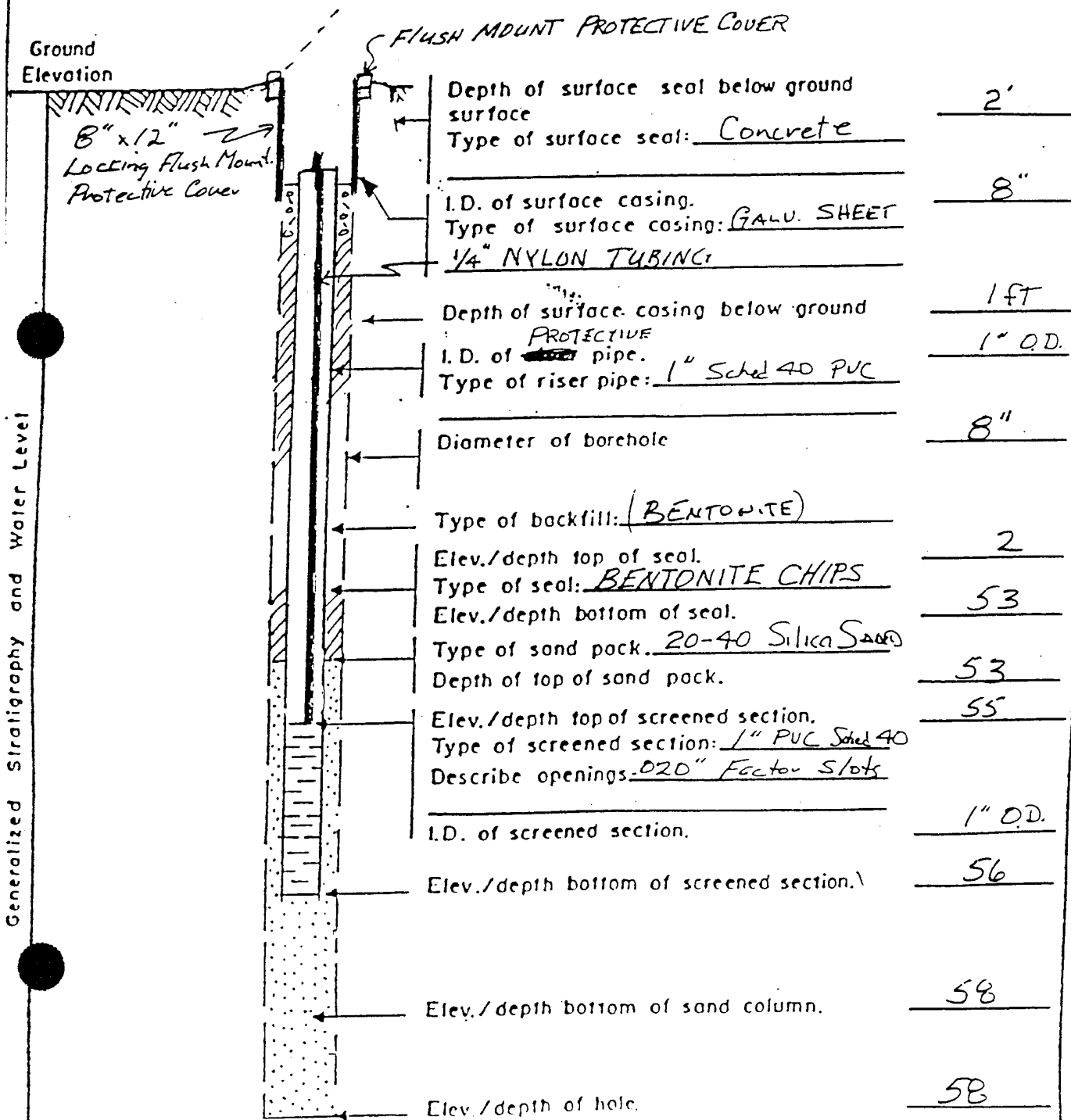
OBSERVATION WELL REPORT

PROJECT <u>RMACOE MOTOR POOL VES</u> <u>B9M11461</u> LOCATION <u>SECTION 4</u> <u>(9948 WLFS)</u> Date Completed <u>6/13/91</u> Original Depth <u>45</u> Inspected By <u>H. MERRELL</u> Date _____ Checked By _____ Date _____	Page <u>1</u> of <u>1</u> Well No. <u>VESP-8B</u> SCREEN Depth Interval <u>42'-43'</u>
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OBSERVATION WELL REPORT

OBJECT <u>RMACOE MOTOR POOL VES</u> <u>89M114G1</u> LOCATION <u>SECTION 4</u> <u>(9948) WCFS</u> Date Completed <u>6/13/91</u> Original Depth <u>58</u> Inspected By <u>H. MERRELL</u> Date _____ Checked By _____ Date _____	Page <u>1</u> of <u>1</u> Well No. <u>VESP-8C</u> SCREEN Depth Interval <u>55-56</u>
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Woodward-Clyde Consultants PROJECT NAME COE MOTOR POOL VES HOLE NO. VES-81

BORING LOCATION <u>SEC 4</u>		ELEVATION AND DATUM	
DRILLING AGENCY <u>LAYNE ENVIRONMENTAL</u>	DRILLER <u>D. WERNER</u>	DATE STARTED <u>6/13/91</u> - <u>6/13/91</u>	
DRILLING EQUIPMENT <u>CME-75</u>	COMPLETION DEPTH <u>15'</u>	SAMPLER	
DRILLING METHOD <u>Hollow Stem Auger</u>	DRILL BIT <u>8"</u>	NO. OF SAMPLES	DIST.
SIZE AND TYPE OF CASING <u>1" Sched 40 PVC</u>	WATER ELEV.	FIRST	COMPL. 24 HRS.
TYPE OF PERFORMANCE <u>Factory Slots .020"</u>	FROM <u>14</u> TO <u>13</u> FT.	LOGGED BY <u>H.W. MERRELL</u>	
SIZE AND TYPE OF PACK <u>20-40 Silica Sand</u>	FROM <u>15</u> TO <u>11</u> FT.	CHECKED BY	
TYPE OF SEAL <u>BENTONITE CHIPS</u>	FROM <u>11</u> TO <u>2</u> FT.		

DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG				SAMPLES				REMARKS (Drill Rate, Fluid loss, Oder, etc.)
		Lithology	Piezometer Installation	Water Content	Piezometer Date	Type No.	Recovery	Penetration (Blows/6 in)		
1	SAND, LT yellow BRN (Munsell) 10YR 4/4 F-Mg, Sub & - Sub Rnd Shl Clayey, Moist. Poorly Graded SP									
2										
3										
4										
5										
6										
7										

PROJECT NO. 89M114G1 (WERS 9948)

SHEET 1 OF 2



DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Piezometer Data	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)
		Lithology	Piezometer Installation			Type No.	Recon. #	Probe Resist Blow (6 in)	
7									
8									
9									
10									
11	SAND LT Yellow BEN F-Cg Sub&-Sub Rnd Pearly Sont, Moist								
12	(SP)								
13									
14									
15									
16									

Woodward-Clyde Consultants PROJECT NAME COE MOTDR POOL VES HOLE NO. VESP-81

BORING LOCATION <u>SEC 4</u>		ELEVATION AND DATUM	
DRILLING AGENCY <u>LAYNE ENVIRONMENTAL</u>	DRILLER <u>D. WERNER</u>	DATE STARTED <u>6/13/91</u>	DATE FINISHED <u>6/13/91</u>
DRILLING EQUIPMENT <u>CME-75</u>		COMPLETION DEPTH <u>45</u>	SAMPLER
DRILLING METHOD <u>Hollow Stem Auger</u>	DRILL BIT <u>8"</u>	NO. OF SAMPLES	DIST.
SIZE AND TYPE OF CASING <u>1" Sched 40 PVC</u>		WATER ELEV.	FIRST
TYPE OF PERFORATION <u>Factory Slots .020"</u>	FROM <u>44</u> TO <u>43</u> FT.	LOGGED BY <u>H.W. MERRELL</u>	CHECKED BY
SIZE AND TYPE OF PACK <u>20-40 Silica Sand</u>	FROM <u>45</u> TO <u>40</u> FT.		
TYPE OF SEAL <u>BENTONITE CHIPS</u>	FROM <u>40</u> TO <u>1</u> FT.		


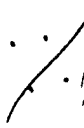

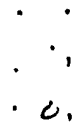

DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG			SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc.)
		Lithology	Piezometer Installation	Water Content	Piezometer Date	Type No.	Recon. Penetration (Blows/6 in)	
1	SAND LT Yellow BEN (Munsell) 10YR 4/4 F-Mg, Subq-Sub P Moist, Poor GRADED Si clayey (SP)							
2								
3								
4								
5								
6								
7								

PROJECT NO. 89M114G1 (WCS 9948)

SHEET 1 OF 6



DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Plasticity Index	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)
		Lithology	Plasticity Index			Type No.	Recon. %	Penet. Resistance (lb/in ²)	
7	(SP)	.	.	.	.	.	.	.
8		.	.	.	.	.	.	.
9		.	.	.	.	.	.	.
10	Sandy yellow BROWN F-Cg, SubK-SubCn Moist, Poor GRADES	.	.	.	.	.	.	.
11		.	.	.	.	.	.	.
12		.	.	.	.	.	.	.
13	(SP)	.	.	.	.	.	.	.
14		.	.	.	.	.	.	.
15		.	.	.	.	.	.	.
16		.	.	.	.	.	.	.

DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Pneumometer Data	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)
		Lithology	Piezometer Installation			Type No.	Recon. #	Penetr. Resist Blow 6 in.	
16	Clayey Sand								
	LT Yellow B&W								
17	(Munsell) 10YR 4/4								
	F-Cg								
18	Poor Graded Moist								
19									
20									
21	TR Fine Gravel & Gnt								
22									
23									
24									
25									

DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Piezometer Data	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)
		Lithology	Piezometer Installation			Type No.	Recon. T1	Recon. Resist Blows 6 in	
25	As Above (SP)	.							
26									
27									
28									
29									
30									
31									
32									
33									
34									
35									
36									
37									
38									
39									
40									



DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Piezometer Data	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc.)
		Lithology	Piezometer Installation			Type No.	Recon. It.	Penetration Resistance (Blows 6 in.)	
35									
36									
37	Clayey Sand LT yellow B&W								
38	SP								
39									
40	Sandy Clay LT yellow B&W								
41	Fg 10% grit								
42	SC/CL								
43									
44									

DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Plasometer Date	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)
		Lithology	Plasometer Installation			Type No.	Recon. II	Penetration Resist Blow (lb/in)	
44	AS ABOVE	///							
45	T.D.	///							
46									
47									
48									
49									
50									
51									
52									
53									

BORING LOCATION <u>SEC 4</u>				ELEVATION AND DATUM			
DRILLING AGENCY <u>LAYNE ENVIRONMENTAL</u>		DRILLER <u>D. WERNER</u>		DATE STARTED <u>6/13/91</u>		DATE FINISHED <u>6/18/91</u>	
DRILLING EQUIPMENT <u>CME-75</u>				COMPLETION DEPTH <u>58'</u>		SAMPLER	
DRILLING METHOD <u>Hollow Stem Auger</u>		DRILL BIT <u>8"</u>		NO. OF SAMPLES		DIST.	
SIZE AND TYPE OF CASING <u>1" Sched 40 PVC</u>				WATER ELEV.		FIRST	
TYPE OF PERFORATION <u>Factory Slots .020"</u>		FROM <u>56</u> TO <u>53</u> FT.		LOGGED BY <u>H.W. MERRELL</u>		CHECKED BY	
SIZE AND TYPE OF PACK <u>20-40 Silica Sand</u>		FROM <u>58</u> TO <u>53</u> FT.					
TYPE OF SEAL <u>BENTONITE CHIPS</u>		FROM <u>53</u> TO <u>2</u> FT.					

DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG				SAMPLES				REMARKS (Drill Rate, Fluid loss, Oder, etc.)
		Lithology	Piezometer Installation	Water Content	Piezometer Date	Type No.	Recon. ZL	Recon. Rndmt. (Blow/6 in.)		
1	<p>SAND LT yellowish Ben (Munsell) 10YR 4/4 F-Mg, Sub & - Sub Rnd Moist, Poor Graded SLi clayey (SP)</p>	.								
2		.								
3		.								
4		.								
5		.								
6		.								
7		.								






DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG			SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)
		Lithology	Piezometer Installation	Water Content	Piezometer Date	Type No.	Recon. #		Penet. Point Blow (6 in)
7	(SP) SAND Lt Yellow BRN F-Cg, Sub & -Sub Rnd Moist, Poor Graded (SP)	.						
8		.						
9		.						
10		.						
11		.						
12		.						
13		.						
14		.						
15		.						
16		.						
		.						
		.						
		.						
		.						
		.						
		.						

DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Plasticity Index	Date	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc.)
		Lithology	Plasticity Installation				Type No.	Recon. (1)	Permeability Blow (6 in)	
16	Clayey SAND LT Yellow BRN	.								
17	Munsell 10YR 4/4 F-Cg, Sub & Sub END. MOIST, POORLY GRADED	.								
18	(SP)	.								
19		.								
20		.								
21	LT Fine Gravel S Grit 1/8" - 1/4"	.								
22		.								
23		.								
24		.								
25		.								



DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG			SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)
		Lithology	Piezometer Installation	Water Content	Piezometer Date	Type No.	Recon. # Penet. # Reinst. Blow 6 in)	
25	SAND Ag Above	.						
26		.						
27		.						
28		.						
29		.						
30		.						
31		.						
32		.						
33		.						
34		.						

DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Piezometer Installation	Date	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc.)
		Lithology	Piezometer Installation				Type No.	Recon. (1)	Penetration Resistance (lb/in ²)	
35	(SP)									
36										
37										
38	Clayey Sand LT Yellow Bk (SP)									
39										
40										
41	Sandy, Clay LT Yellow Bk Fg, Sub A - Sub rad 1% Grit. E Clay (SC/CL)									
42										
43										
44										



DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Piezometer Installation	Date	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)
		Lithology	Piezometer Installation				Type No.	Recon. No.	Probe Resist Blow (B.H.)	
44	Sandy Clay A A-5									
45	Lt Clay Lt yellow Bcl Med plastic									
46	SAND Sci Clayey									
47	Lt yellow Bcl F-Cg, Sub & -Sub Rnd Poor Graded Moist-									
48										
49										
50										
51										
52										
53										





DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG			Pisometer Date	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)
		Lithology	Piezometer Installation	Water Content		Type No.	Recon. #	Penetration Resistance (Blows 3 in)	
53									
54									
55	Clayey SAND LT yell. BRN F-Gz Sub A-Sub Bnd 10% fines, Low plastic TR grit.								
56									
57	SP								
58	SB T.D								

BORING LOCATION <u>Sec 4 RMA</u>		ELEVATION AND DATUM	
DRILLING AGENCY <u>Layne Western</u>	DRILLER <u>D. WERNER</u>	DATE STARTED <u>6/6/91</u> - <u>6/6/91</u>	
DRILLING EQUIPMENT <u>CME 75</u>	<u>10 1/2 OD</u>	COMPLETION DEPTH <u>30</u>	SAMPLER
DRILLING METHOD <u>Rotary Stem</u>	DRILL BIT <u>6 1/4 ID</u>	NO. OF SAMPLES	DIST.
SIZE AND TYPE OF CASING <u>4" PVC Sched 40</u>		WATER ELEV.	FIRST
TYPE OF PERFORATION <u>.020</u>	FROM <u>28</u> TO <u>13</u> FT.	LOGGED BY <u>H.W. MERRELL</u>	CHECKED BY
SIZE AND TYPE OF PACK <u>SAND 6-9</u>	FROM <u>30</u> TO <u>11</u> FT.		
TYPE OF SEAL <u>Bentonite</u>	FROM <u>11</u> TO <u>5.5</u> FT.		

DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Plazometer Date	SAMPLES			REMARKS (Drill Rate, Fluid loss, Oder, etc.)
		Lithology	Plazometer Installation			Type No.	Recovery %	Penetration (Blows/6 in.)	
1	2 inch gravel 2" deep at Surface Gray Volc. (Ballast)	SC							Gravel for RR Ballast
2	Clayey Clayey Sand, F-Med grain, siliceous, Poor Graded, Sub 4 Sand 90%, moist, Munsell 10 YR 3/4 dark yellowish Brown (SC)								
3									
4									
5	Clayey Sand as above								
6									
7									



DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Piezometer Data	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)
		Lithology	Piezometer Installation			Type No.	Recon. (1)	Penetration Resistance (Blows 6 in)	
7									
8									
9									
10	Clayey Sand, Dark yellow brown								
	Munsell 10YR 3/4, F-Mgr.								
11	Sub X -Sub rnd, Poor Graded								
	Silicaceous, moist,								
	clay ~ 5% (SC)								
12									
13									
14									
15									
16									

DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Piezometer Date	SAMPLES				REMARKS (Drill Rate, Fluid loss, Odor, etc)
		Lithology	Piezometer Installation			Type No.	Recon. (1)	Penetration Blow (6 in)		
16	Clayey SAND, LT yellowish Brown, Munsell 10YR 3/4									
17	moist, F-Mg sand, Sd 4-Sd brnd, Sci micaceous (SC)									
18										
19	Sci amount of 1/8"-1/4" frt. 19%±									
20	Clayey Sand as above									
21										
22										
23	TR clay balls 10YR 4/4									
24	TR 1/4"-1/8" grit									
25										



DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Piezometer Date	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)
		Lithology	Piezometer Installation			Type No.	Recon. T	Penetr. Resist. Blows (6 in)	
25	Clayey Sand LT yellow BED								
	10XR 3/4 (Munsell)								
26	Moist, F-Mg Sand, Sub								
	Redd; ^{TR} fine grained								
	Sub and grit 1/4" & Fg gravel								
27	up to 1/2" (2-3%).								
28									
29									
30									

BORING LOCATION <u>Sec 4</u>				ELEVATION AND DATUM				
DRILLING AGENCY <u>Layne Western</u>			DRILLER <u>D. Werner</u>		DATE STARTED <u>6/7/91</u>			
DRILLING EQUIPMENT <u>CME 75</u>			<u>10 1/2 OD</u>		COMPLETION DEPTH <u>60</u>		SAMPLER	
DRILLING METHOD <u>Hollow Stem Auger</u>			DRILL BIT <u>6 1/4 ID</u>		NO. OF SAMPLES		DIST.	
SIZE AND TYPE OF CASING <u>4" PVC</u>				WATER ELEV.		FIRST	COMPL. 24 HRS.	
TYPE OF PERFORATION <u>Factory slot 0.20</u>				FROM <u>58</u> TO <u>43</u> FT.		LOGGED BY		
SIZE AND TYPE OF PACK <u>Sand 6-9-</u>				FROM <u>60</u> TO <u>40</u> FT.		CHECKED BY		
TYPE OF SEAL <u>Bentonite</u>				FROM <u>40</u> TO <u>35</u> FT.				
DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG			SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc.)
		Lithology	Piezometer Installation	Water Content	Piezometer Data	Type No.	Recon./L	
1	2" Volc. Gravel (R.P. Ballast) 2" Soil BLE - DKGy	Δ Δ						
2	Clay, Sand, DARK Yellow BGN Munsell 10YR 4/4 F-Mg, Sub A - Sub Bnd. Moist. Less than 5% fines. Non Plastic Clay material (SC)	/						
3		/						
4		/						
5	As Above w/ Clay inc. to ~10%	/						
6	SLIMORE plastic	/						
7		/						



DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Piezometer Data	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)
		Lithology	Piezometer Installation			Type No.	Recon. (t)	Penetration Resist Blows (6 in)	
7									
8									
9									
10	Cloey Sand, DRK Yellow Brown (Munsell 10YR 4/4 Med-Coarse grained, Sub & - Sub End, Very SLt amount of fines < 5% Moist (SC)								
11									
12									
13									
14									
15									
16									

DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Piezometer Data	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)	
		Lithology	Piezometer Installation			Type No.	Recon. #	Penetration Resist Blow (6 in)		
16	Sand Med, Coarse Gr Sub $\frac{1}{2}$, Sub Rnd, Poor Sort. with 5% Fine Gravel $\frac{3}{16}$ - $\frac{1}{4}$ " Sub rnded gr Poorly Sorted moist. (SP)	.								
17		.								
18		.								
19		.								
20	Sand DK Red Yellow BRN Munsell 10YR 4/4 Sand, Med-Coarse gr Sub $\frac{1}{2}$ - Sub Rnd. 10% Fine gravel $\frac{1}{8}$ " - $\frac{1}{2}$ " - Sub rnd w/ <u>BLK</u> <u>Staining</u> around frags. No Odor, Moist. (SP)	.								
21		.								
22		.								
23		.								
24		.								
25		.								

DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Piezometer Date	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)
		Lithology	Piezometer Installation			Type No.	Recon. T	Penetra. Resist. Blows 6 in.	
25	Sand DK Yellow BEN	0							
	C-VC grained, sub &-	.							
	Sub Rnd, Moist.;	.							
26	Fine Gravel 1/8 - 1/4" Ben	0							
	Sub Rnd. (20%)	.							
		.							
27	(SP)	0							
		.							
		.							
		0							
28		.							
		.							
		.							
		0							
29		.							
		.							
		0							
30		.							
		.							
		0							
31		.							
		.							
		0							
		.							
		0							
32		.							
		.							
		0							
33	Sand, DK BEN, F-Mgr	.							
	Munsen 104R 4/3, moist	00							Drly slowed at 33'
	15% Fine Gravel 1/4 - 1/2"	00							
		.							
34		.							



DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Plasometer	Ditto	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)
		Lithology	Plasometer material				Type No.	Recon. #	Penetration Resistance (Blow 6 in)	
34	Sand DK BRN F-Mg moist, Sub X - Sub Rnd 10% Gravel 1/4-3/8 rnz/Sub Rnd	oo								
35		o								
36	Clayey Sand DK Yellow BRN Munsell 10YR 4/4 Silty mixtures	///								
37	(SM /SC)(ML) finer $\approx 10-15\%$	///								
38	Sand F-Mg - Cg with occasional 1/8" grit.	///								
39		///								
40	S	///								
41	Clayey Sand DK. yell. BRN F-Mg, Sub X - Sub Rnd few 1/8" grit grains	///								
42	(SC)/(ML)	///								
43		///								



DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Plasometer Data	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)
		Lithology	Plasometer Interpretation			Type No.	Recon. #	Depth Below Blow 6 in.	
43									
44									
45	Clayey S. lty SAND DE Yellow BRN.								
46	Munsell 10YR 4/4 F-C grained sub. end. Moist.								
47	Fines = (10-15%) F Gravel 1/8"-3/8" (20%)								
48	(SC)								
49									
50									
51									
52									

DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Piezometer Date	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)
		Lithology	Piezometer Installation			Type No.	Recon. ft.	Penetration Resistance (Blows 6 in)	
52	Clayey Silty Sand DK Yellow BAN 10 YR 4/4 (Munsell) F-Mg Sand Sub Rnd - Sub X. Moist. Little Fine Gravel 1/8 - 1/4" Sub Rnd.								
53									
54									
55									
56									
57	(SC)								
58									
59									
60	T.D 60'								

Woodward-Clyde Consultants

PROJECT NAME MACOE Motor Pool VES HOLE NO. UESP-5A

BORING LOCATION <u>Sec 4</u>		ELEVATION AND DATUM	
DRILLING AGENCY <u>Layne Environmental</u>	DRILLER <u>D. WERNER</u>	DATE STARTED <u>6/11/91</u> — <u>6/11/91</u>	
DRILLING EQUIPMENT <u>CME 75'</u>		COMPLETION DEPTH <u>15</u>	SAMPLER
DRILLING METHOD <u>Hollow Stem Auger</u>	DRILL BIT <u>8"</u>	NO. OF SAMPLES	DIST.
SIZE AND TYPE OF CASING <u>1" PVC</u>		WATER ELEV.	FIRST
TYPE OF PERFORATION <u>1" PVC Fact Slots 0.20"</u>	FROM <u>13</u> TO <u>12</u> FT.	LOGGED BY <u>H.W. MCCRACK</u>	
SIZE AND TYPE OF PACK <u>Silica 20-40</u>	FROM <u>15</u> TO <u>10</u> FT.	CHECKED BY	
TYPE OF SEAL <u>Bentonite</u>	FROM <u>10</u> TO <u>2</u> FT.		

DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG				SAMPLES			REMARKS (Drill Rate, Fluid loss, Oder, etc.)
		Lithology	Piezometer Installation	Water Content	Piezometer Date	Type No.	Recon. / L	Penetration Resist. (Below 6 in)	
1	SAND, Clayey, Lt Yellow Bee								
2	F-Mg, Sub & - Sub Rnd								
	Sci Amount of Clay.								
	Moist								
	(SC)								
3									
4									
5									
6									
7									

PROJECT NO. WCC 89M114G1

(9948)

SHEET 1 OF 2



DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG			SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)	
		Lithology	Plasometer Installation	Water Content	Plasometer Date	Type No.	Recon. #		Penetration Resistance Blow (6 in.)
7	AS ABOVE								
8	(SC)								
9									
10	SAND, LT yellow BRN,								
11	SUB & - Sub Rnd, moist								
	Poor Graded								
12	(SP)								
13									
14									
15	T.O.								



BORING LOCATION <u>Sec 4 Motor Pool</u>				ELEVATION AND DATUM				
DRILLING AGENCY <u>Layne Environmental</u>		DRILLER <u>D. Werner</u>		DATE STARTED <u>6/10/91</u>		DATE FINISHED <u>6/10/91</u>		
DRILLING EQUIPMENT <u>CME-75</u>				COMPLETION DEPTH		SAMPLER		
DRILLING METHOD <u>Hollow Stem Auger</u>		DRILL BIT <u>3 3/4 ID, HSA</u>		NO. OF SAMPLES		DIST.		
SIZE AND TYPE OF CASING <u>1" PVC Silted to</u>				WATER ELEV.		FIRST		
TYPE OF PERFORATION <u>Fact. Slots 0.20"</u>				FROM <u>37</u> TO <u>36</u> FT.		LOGGED BY <u>H.W. MERRELL</u>		
SIZE AND TYPE OF PACK <u>20-40 Silica</u>				FROM <u>39</u> TO <u>34</u> FT.		CHECKED BY		
TYPE OF SEAL <u>Bentonite Mud Chips</u>				FROM <u>34</u> TO <u>29</u> FT.				
DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG			SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc.)
		Lithology	Piezometer Installation	Water Content	Piezometer Date	Type No.	Recovery Penetration Resistance (Blow/ft)	
1	Clayey Sand LT Yellow Br. moist. (SC)	/						
2								
3								
4								
5								
6								
7								



DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Plasometer Data	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)
		Lithology	Plasometer Installation			Type No.	Recon. (1)	Penetration Resist Blows (6 in)	
7									
8									
9									
10	Sand SLi Clayey								
11	(SP)								
12									
13									
14									
15									
16									

DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Piezometer Depth	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)
		Lithology	Piezometer Installation			Type No.	Recon. (1)	Recon. (2) Blow (6 in)	
16									
17									
18	Becon Ski Clayey w/ Small occ. Chert								
19									
20	Sand lt yellow BCU F-Mg, Sub & - Sub Rm Moist								
21	SP								
22									
23									
24									
25									

DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Plazometer	Date	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)
		Lithology	Plazometer Installation				Type No.	Recon. U	Penetration Resistance (Blows 6 in)	
25	SAND LT Yellow BRN (Munsell) 10YR 4/4 F-Cg moist. Sub & - Sub End. (SP)	.								
26										
27										
28		.								
29										
30										
31	CLAYEY, SILTY SAND LT Yellow BRN, Moist Sub & - Sub End. (SC)/(ML)	.								
32										
33										
34		.								





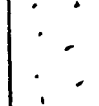
PROJECT NO. WCC 89M114G1

BORING LOCATION <u>Section 4 RMA</u>		ELEVATION AND DATUM	
DRILLING AGENCY <u>LAYNE ENVIRONMENTAL</u>	DRILLER <u>D. WERNER</u>	DATE STARTED <u>6/10/91</u> — DATE FINISHED <u>6/10/91</u>	
DRILLING EQUIPMENT <u>CME 75</u>		COMPLETION DEPTH	SAMPLER
DRILLING METHOD <u>Hollow Stem Auger</u>	DRILL BIT	NO. OF SAMPLES	DIST.
SIZE AND TYPE OF CASING <u>1" PVC</u>		WATER ELEV.	FIRST
TYPE OF PERFORATION <u>Fact. Slots .020"</u>	FROM <u>53</u> TO <u>52</u> FT.	LOGGED BY <u>H. Merrell</u>	
SIZE AND TYPE OF PACK <u>20/40 Silica Sand</u>	FROM <u>54 1/2</u> TO <u>50</u> FT.	CHECKED BY	
TYPE OF SEAL <u>Bentonite Chips</u>	FROM <u>50</u> TO <u>44 1/2</u> FT.		

DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG				SAMPLES			REMARKS (Drill Rate, Fluid loss, Oder, etc.)
		Lithology	Piezometer Installation	Water Content	Piezometer Date	Type No.	Recon. Penetration (Blow/6 in)		
0	TRACE (2"±) Blue Soil & Ballast Gravel	25-							
1	SAND, LT Yellow BAW, (Munsell) 10YR 4/4								
2	F-Mg, Sub sand; Sub & moist. TE fines								
3	(5C)								
4									
5									
6									
7									



DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Piezometer Installation	Date	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)
		Lithology	Piezometer Installation				Type No.	Recon. ft.	Penetration Resistance (Blows 6 in)	
7	AS above									
8										
9										
10										
10	SAND LT YELLOW BRN (Munsell) 10YR 4/2									
11	F-Mg, Subord-Sub & Moist, Poorly graded									
12										
13										
14										
15										
16										

DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Pneumometer Installation	Type No.	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)
		Lithology	Pneumometer Installation				Recon. #	Penetration Resistance (lb/in)		
16	Clayey Sand at Yellow Ben Munsell 10YR 4/4 F-Mg, Poor Grade b Moist. SUB & - Sub End.									
17										
18										
19										
20										
21										
22										
23										
24										
25										



DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Piezometer Depth	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)
		Lithology	Piezometer Installation			Type No.	Recon. (1)	Penetration Resist Blow (6 in)	
25	As Above								
26									
27									
28									
29									
30									
31									
32									
33	Clayey Sand, LT Yellow BBW Sub Rnd/Sub X, Fg, Very Clayey w. 42 SLT.								
34									

DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Piezometer Data	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)
		Lithology	Piezometer Installation			Type No.	Recon. (1)	Recon. (2)	
34									
35	Cloey Sand LT yellow B&W Moist Munsell D/R 4/4 M-Mg Sand, SB & Sub Rnd								
36	TR BLK Clay L 10% (SC)/(ML)								
37									
38									
39									
40	SAND LT yellow B&W F-Mg Sub A - Sub Rnd								
41	Mois Poorly Graded (SP)								
42									
43									

DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG			SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)
		Lithology	Piezometer Installation	Water Content	Piezometer Date	Type No.	Recon. (t)	
43	Sand AS ABOVE (SP)							
44								
45	SAND Clayey Sand, LT Yell. B&W F-Mg							
46								
47								
48								
49								
50	SAND F-Mg Most SUB 4, Sub End. (SP)							
51								
52								

PROJECT NO. 89M114G1

DRILLING LOCATION <u>SEC 4</u>		ELEVATION AND DATUM	
DRILLING AGENCY <u>LAYNE ENVIRONMENTAL</u>	DRILLER <u>D. WAGNER</u>	DATE STARTED <u>6/13/91</u> - <u>6/13/91</u>	
DRILLING EQUIPMENT <u>CME-75</u>		COMPLETION DEPTH <u>15'</u>	SAMPLER
DRILLING METHOD <u>Hollow Stem Auger</u>	DRILL BIT <u>8"</u>	NO. OF SAMPLES	DIST.
SIZE AND TYPE OF CASING <u>1" Sched 40 PVC</u>		WATER ELEV.	FIRST
TYPE OF PERFORMANCE <u>Factory Slots .020"</u>	FROM <u>14</u> TO <u>13</u> FT.	LOGGED BY <u>H.W. MERRELL</u>	
SIZE AND TYPE OF PACK <u>20-40 Silica Sand</u>	FROM <u>15</u> TO <u>11</u> FT.	CHECKED BY	
TYPE OF SEAL <u>BENTONITE CHIPS</u>	FROM <u>11</u> TO <u>01</u> FT.		

DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Plasticity Index	Type No.	Recovery	Penetration (Blows/ft)	REMARKS (Drill Rate, Fluid loss, Odor, etc.)
		Lithology	Plasticity Index						
1	SAND, SLT clayey LT Yellow Bcn (Munsell) 10YR 4/4 F-Mg, Subq-Sub END Moist, POORLY GRADED								
2									
3	(SP)								
4									
5									
6									
7									



DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Piezometer Data	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)
		Lithology	Piezometer Installation			Type No.	Recon. (1)	Penetration Blow Count (6 in)	
7									
8									
9									
10	SAND								
11	AS ABOVE								
	Fines decr.								
12									
13									
14									
15									
16									

15'
T.D.

BORING LOCATION <u>SEC 4</u>				ELEVATION AND DATUM			
DRILLING AGENCY <u>LAYNE ENVIRONMENTAL</u>		DRILLER <u>D. WERNER</u>		DATE STARTED <u>6/12/91</u> - <u>6/13/91</u>		DATE FINISHED	
DRILLING EQUIPMENT <u>CME-75</u>				COMPLETION DEPTH <u>44</u>		SAMPLER	
DRILLING METHOD <u>Hollow Stem Auger</u>		DRILL BIT <u>8"</u>		NO. OF SAMPLES		DIST.	
SIZE AND TYPE OF CASING <u>1" Sched 40 PVC</u>				WATER ELEV.		FIRST	
TYPE OF PERFORATION <u>Factory Slots .020"</u>				FROM <u>43</u> TO <u>42</u> FT.		LOGGED BY <u>H.W. MERRELL</u>	
SIZE AND TYPE OF PACK <u>20-40 Silica Sand</u>				FROM <u>44</u> TO <u>40</u> FT.		CHECKED BY	
TYPE OF SEAL <u>BENTONITE CHIPS</u>				FROM <u>40</u> TO <u>2</u> FT.			

DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Plasticity Index	SAMPLES			REMARKS (Drill Rate, Fluid loss, Oder, etc.)
		Lithology	Piezometer Installation			Type No.	Recon. No.	Penetration (Blow/6 in)	
1	SAND SLi Clayey LT yellow BRN (Munsell) 10YR 4/4 F-Mg, SubX-Sub v Moist, Poor Grade	.	.	.	.	.	.	.
2									
3	(SP)	.	.	.	.	.	.	.
4		.	.	.	.	.	.	.
5		.	.	.	.	.	.	.
6		.	.	.	.	.	.	.
7		.	.	.	.	.	.	.












DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Piezometer Date	SAMPLES			REMARKS (Orbit Rate, Fluid loss, Odor, etc)
		Lithology	Piezometer Installation			Type No.	Recon. ft	Penetration Resistance (Blow 6 in)	
7	AS ABOVE								
8									
9									
10									
11									
12									
13									
14									
15									
16									



DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Pneumometer Data	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)
		Lithology	Pneumometer Installation			Type No.	Recon. (1)	Penetration Test (Blow 6 in)	
16									
17									
18									
19									
20	SAND, Gravelly LT Yellow BRN (Munsell) 10YR 4/4								
21	F-Mg - TE 1/8" Gravel F-Mg - Sub & Moist, Poorly GRADED (SP)								
22									
23									
24									
25									

DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Piezometer Data	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)
		Lithology	Piezometer Installation			Type No.	Recon. (1)	Penetration Resistance (Blows 6 in)	
25									
26	(SP)								
27									
28									
29									
30	SAND LT Yellow BRN F-Cg, Sub 4 - Sub 6 Rows								
31	Most - Poorly Graded TR 1/4" Gravel								
32	(SP)								
33									
34									

DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Piezometer Date	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)
		Lithology	Piezometer Installation			Type No.	Recon. (1)	Penetration Resistance (Blows 6 in)	
35	SAND LT Yellow BEN								
	F-Mg, Sub C - Sub R.								
	Moist Poorly Graded								
36									
37	SP								
38									
39									
40	Sandy, SLTY Clay,								
	LT yellow BEN								
	(Munsell) 10YR 4/4								
	Med Plastic, Moist								
41	(CL/ML)								
42									
43									
44	44' TD								

BORING LOCATION <u>SEC 4</u>		ELEVATION AND DATUM	
DRILLING AGENCY <u>LAYNE ENVIRONMENTAL</u>	DRILLER <u>D. WERNER</u>	DATE STARTED <u>6/12/91</u> — <u>6/12/91</u>	
DRILLING EQUIPMENT <u>CME-75</u>		COMPLETION DEPTH <u>58'</u>	SAMPLER
DRILLING METHOD <u>Hollow Stem Auger</u>	DRILL BIT <u>8"</u>	NO. OF SAMPLES	DIST.
SIZE AND TYPE OF CASING <u>1" Sched 40 PVC</u>		WATER ELEV.	FIRST
TYPE OF PERFORATION <u>Factory Slots .020"</u>	FROM <u>56</u> TO <u>55</u> FT.	LOGGED BY <u>H.W. MERRELL</u>	
SIZE AND TYPE OF PACK <u>20-40 Silica Sand</u>	FROM <u>58</u> TO <u>53</u> FT.	CHECKED BY	
TYPE OF SEAL <u>BENTONITE CHIPS</u>	FROM <u>53</u> TO <u>1</u> FT.		

DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Pneumometer	Type No.	SAMPLES		REMARKS (Drill Rate, Fluid loss, Odor, etc.)
		Lithology	Piezometer Installation				Recon. No.	Penetration (Blow/6 in)	
1	2" Gravel (R.R. Ballast)	2.2 x 2							
1	Sand, silty sands of fines F-Mg, Sub X - Sub Rnd								
1	Moist Poorly Graded TR Clay $\leq 2\%$?								
2	LT Yellow Ben (Munsell) 10YR 4/4 (SP)								
3									
4									
5									
6									
7									



DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Plastimeter Date	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)
		Lithology	Plastimeter Installation			Type No.	Recon. #	Sample Depth (ft)	
7	AS ABOVE								
8									
9									
10	Sand AS ABOVE Finer decr. to nil								
11	(SP)								
12									
13									
14									
15									
16									



DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Piezometer Data	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)
		Lithology	Piezometer Installation			Type No.	Recon. II	Penet. II	
16	SAN LT YELLOW BED	.							
	F-Mg, Sub & Sub End								
17	Moist, Poor Graded	.							
18		.							
	Te 3/8" gravel Sub End	.							
19		.							
		.							
20	Gravelly Sand LT Yellow Bed	.							
	F-Cg, Sub Sub & Sub End	.							
21	Poorly Graded, Moist	.							
	(SP)	.							
22		.							
		.							
23		.							
		.							
24		.							
		.							
25		.							



DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Piezometer Date	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)
		Lithology	Piezometer Installation			Type No.	Recon. T	Penetration Resistance (Blows 6 in)	
25	Gravelly Sand AS Above	.							
26	Gravel 10% ±	.							
27		.							
28		.							
29		.							
30	Gravel size 1 inch to maximum 1/2" x 3/4"	.							
31		.							
32		.							
33		.							
34		.							



DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Piezometer Data	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)
		Lithology	Piezometer Installation			Type No.	Secor. #	Penet. Resist. Blows (6 in)	
35									
36									
37	SAND . Clayey								
38									
39									
40	Clayey Sandy, Clay & FE S.C.T.								
41	Shi Plastic, Sand Fg, TR gravel '18"								
42	(CL/ML)								
43									
44									

DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Piezometer Data	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)
		Lithology	Piezometer Installation			Type No.	Recon. T1	Penet. Resist. Blows (6 in)	
44									
45	As Above w/ few 1" gravel, Rnded E 1/8" gr. Clay content decr.								
46	TE DEGY-BLK SH Cky Beds Moist								
47	(SP)								
48									
49									
50	SAND F-Cg Sub & Sub End								
51									
52									
53									

PROJECT NO. 89M114G1

BORING LOCATION <u>SEC 4</u>				ELEVATION AND DATUM				
DRILLING AGENCY <u>Layne Environmental</u>			DRILLER <u>D. WERNER</u>		DATE STARTED <u>6/12/91</u> - <u>6/12/91</u>			
DRILLING EQUIPMENT <u>CME 75</u>				COMPLETION DEPTH <u>15'</u>		SAMPLER		
DRILLING METHOD <u>Wallow Stem Auger</u>			DRILL BIT <u>8"</u>		NO. OF SAMPLES		DIST.	
SIZE AND TYPE OF CASING <u>1" Sched 40 PVC</u>				WATER ELEV.		FIRST		
TYPE OF PERFORATION <u>1" PVC Factory Slots</u>				FROM <u>13</u> TO <u>12</u> FT.		LOGGED BY <u>H.W. MERRELL</u>		
SIZE AND TYPE OF PACK <u>20/40 Silica Sand</u>				FROM <u>15</u> TO <u>10</u> FT.		CHECKED BY		
TYPE OF SEAL <u>Bentonite Chips</u>				FROM <u>10</u> TO <u>1</u> FT.				
DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG			SAMPLES			REMARKS (Drill Rate, Fluid loss, Oder, etc.)
		Lithology	Piezometer Installation	Water Content	Piezometer Date	Type No.	Recon./L. Penetration (Blow/6 in)	
0	2" BLK Soil							
1	SAND, Clayey, LT yellow Ben Munsell 10YR 4/4 F-Mgr., Sub 4 -Sub Rnd Moist, Poorly Graded Fines ~ 5%							
2	(SP)							
3								
4								
5								
6								
7								

PROJECT NO. 89M11461

Woodward-Clyde Consultants

PROJECT NAME RMA COE Motor Pool VES HOLE NO. VESP-7_L

BORING LOCATION <u>Sec 4</u>		ELEVATION AND DATUM	
DRILLING AGENCY <u>Keyne Environmental</u>	DRILLER <u>D. Wernig</u>	DATE STARTED <u>6/11/91</u> - <u>6/11/91</u>	
DRILLING EQUIPMENT <u>CME-75</u>		COMPLETION DEPTH <u>48</u>	SAMPLER
DRILLING METHOD <u>Hollow Stem Auger</u>	DRILL BIT <u>8"</u>	NO. OF SAMPLES	DIST.
SIZE AND TYPE OF CASING <u>1" PVC Sched 40</u>		WATER ELEV.	FIRST
TYPE OF PERFORMANCE <u>Factory Slots - 020</u>	FROM <u>46</u> TO <u>45</u> FT.	LOGGED BY <u>H. Merrell</u>	
SIZE AND TYPE OF PACK <u>AD-40 Silice</u>	FROM <u>48</u> TO <u>43</u> FT.	CHECKED BY	
TYPE OF SEAL <u>Bentonite Chms</u>	FROM <u>43</u> TO <u>38</u> FT.		

DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG				SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc.)
		Lithology	Piezometer Installation	Water Content	Piezometer Date	Type No.	Recon. JL	Penetration Resistance (Blows/ 6 in)	
1	SAND, clayey, LT yellow BAN (Munsell) 10YR 4/4 F-Mg, Sub & - Sub Rnd Poor Graded, Moist Trace fines, non-plastic	/							
2		/							
3	(SP)	/							
4		/							
5		/							
6		/							
7		/							

PROJECT NO. WCC 89M11461 (9948)SHEET 1 OF 6

DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Piezometer Data	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)
		Lithology	Piezometer Installation			Type No.	Recon. (1)	Penetration Resist. Below G.I.	
7	As Above (SP)	✓							
8									
9		✓							
10	SAND LT-Yellow BLD F-Mg Sub X -Sub Rnd								
11									
12	Fines decr. (SP)								
13									
14									
15									
16									

DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG			SAMPLES				REMARKS (Drill Rate, Fluid loss, Odor, etc.)
		Lithology	Piezometer Installation	Water Content	Piezometer Date	Type No.	Recon. (1)	Pressure Retest Blow (6 in)	
16	S&WD LT Yellow B&O	.							
17	M-Cg, Sub & - Sub End	/							
18	Most Poor Soil. Trace Grit 1/8 - 1/4" (1-2%) TR Fine's (SP)	.							
19		/							
20		.							
21		.							
22		.							
23		.							
24		.							
25		.							

DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Piezometer Date	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)
		Lithology	Piezometer Installation			Type No.	Recon. (1)	Recon. (2)	
25	SAND LT yellow BEN	.	.	.	.	.	.	.
	M-Cg, Sub End Moist	.	.	.	.	.	.	.
26	Some Grit 1/8" - 1/4" 10%	.	.	.	.	.	.	.
	Sub Rnd	.	.	.	.	.	.	.
27	(SP)	.	.	.	.	.	.	.
		
28		.	.	.	.	.	.	.
		
29		.	.	.	.	.	.	.
		
30	As above	.	.	.	.	.	.	.
	Gravel incr to 15%	.	.	.	.	.	.	.
	& 1/8" - 1/2"	.	.	.	.	.	.	.
31	Moist Poor Solt	.	.	.	.	.	.	.
		
32	(SP)	.	.	.	.	.	.	.
		
33		.	.	.	.	.	.	.
		
34		.	.	.	.	.	.	.



DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Piezometer Date	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)
		Lithology	Piezometer Installation			Type No.	Recon. (t)	Probe Resist Blow (6 in)	
34	Gravelly SAND, LT Yellow BED Poor GRADED. Moist H-Cg, Sub 4 - Sub End. 20% Fine Gravel & Grit	.							
35		.							
36		.							
37		.							
38		.							
39		.							
40		.							
41		.							
42	SAND, clayey LT Yellow BED F-Mg Sub 4 Moist, Poor Graded (SP)	.							
43		.							



DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Pneumeter Dials	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc.)
		Lithology	Pneumeter Installation			Type No.	Recon. (1)	Penetration Resistance (Blows 6 in.)	
43	As Above								
44	(SP)								
45	SAND & CLAY LT yellow BEN F-Mg								
46	Low Plastic, Moist								
47	CL/SP								
48	T.D. —								



BORING LOCATION <u>SEC 4</u>		ELEVATION AND DATUM	
DRILLING AGENCY <u>LAYNE Environmental</u>		DRILLER <u>D. WERNER</u>	
DRILLING EQUIPMENT <u>CME 75</u>		DATE STARTED <u>6/11/91</u> DATE FINISHED	
DRILLING METHOD <u>Hollow Stem Auger</u>		COMPLETION DEPTH <u>58</u> SAMPLER	
SIZE AND TYPE OF CASING <u>1" PVC Sched 40</u>		NO. OF SAMPLES	
TYPE OF PERFORATION <u>PVC Sched 40, 1"</u>		DIST.	
SIZE AND TYPE OF PACK <u>Silica 20-40</u>		WATER ELEV.	
TYPE OF SEAL <u>Bentonite Chips</u>		FIRST	
FROM <u>56</u> TO <u>55</u> FT.		UNDIST.	
FROM <u>58</u> TO <u>53</u> FT.		COMPL. 24 HRS.	
FROM <u>53</u> TO <u>48</u> FT.		LOGGED BY <u>H.W. MERRELL</u>	
		CHECKED BY	

DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG			SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc.)
		Lithology	Piezometer Installation	Water Content	Piezometer Data	Type No.	Recovery Penetration Resistance (Blows/ 6 in)	
1	Clayey Sand, LT Yellow BSW (Munsell) 10YR 4/4 F-Mg, Sub & - Sub Rnd Moist, non-plastic Poorly Graded, moist.	/						
2		/						
3	(SE) SE SP	/						
4		/						
5		/						
6		/						
7		/						



DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Piezometer Dials	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)
		Lithology	Piezometer Installation			Type No.	Recon. (1)	Penetration Resistance (Blow 6 in.)	
7	Clayey Sand As Above	/							
8	SP	/							
9		/							
10	SAND, SLI Clayey LT yellow BAN.	/							
11	F-C g. (few 1/8" grains) Sub & - Sub and Clay & Fines Reduced TO FACE	/							
12	Poorly Graded, moist	/							
13	(SE) (SP)	/							
14		/							
15		/							
16		/							



DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Piezometer Installation	Piezometer Date	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)
		Lithology	Piezometer Installation				Type No.	Recon. II	Penetration Resistance Blows (ft/in)	
16	SAND AS ABOVE	/								
17	SC/SP	.								
18		.								
19		.								
20	SAND LT yellow BBN (Munsell) 10YR 4/4	.								
21	F-C g 5% Fine Gravel (Grit) 1/8 - 1/4"	.								
22	Moist Poor Graded (SP)	.								
23		.								
24		.								
25		.								



DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Pneumometer Data	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)
		Lithology	Pneumometer Installation			Type No.	Recon. ft	Penetration Resistance (Blow 6 in.)	
25	SAND AS ABOVE								
26									
27	(SP)								
28									
29									
30									
31	SAND, Shlicky Lt yellow Bk Moist, Poor Grades								
32	F Mg. 1 TR Grit size (SP)								
33									
34									



DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Piezometer Installation	Date	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)
		Lithology	Piezometer Installation				Type No.	Recon. (1)	Penetration Resist (Blow 6 in)	
34		/								
35	SAND, Silty Clayey	.								
	LT Yellow BRN,	.								
36	F-Mg, Sub 4-Sub R.	/								
	Non Plastic, Moist	.								
	LT Grt sized grains	.								
37	SP	.								
38		/								
39		.								
40		/								
41	Sand LT Yellow BRN	.								
	M-Cg, Sub 4-Sub Rnd, Moist	.								
42	Clay, Plastic, Moist	.								
	Exhib 1042 4/4	.								
43		.								

DEPTH (FEET)	DESCRIPTION	GRAPHIC LOG		Water Content	Piezometer Data	SAMPLES			REMARKS (Drill Rate, Fluid loss, Odor, etc)
		Lithology	Piezometer Installation			Type No.	Recon. II	Penetr. Resist. Blow (6 in)	
43	SAND & CLAY as Above								
44									
45									
46	CLAY SOFT, SLI Plastic, moist; Some Sand & SLT - 30%								
47	(CL)								
48									
49									
50	SAND LT Yellow BEU F-Mg MOIST								
51	TR 60T sized gr. Clayey								
52	(SP)								

PROJECT NO. 89M11461

APPENDIX B
ANALYTICAL CHEMISTRY RESULTS



ANALYTICAL REPORT

Form ARF-AL

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Part 1 of 1

Date 7/29/91Agency Identification Number 91-1959Account No. 03019

Woodward-Clyde Consultants
4582 South Ulster Street Parkway
Standford Place 3, Suite 1000
Denver, CO 80237
Attention: Jeff Cox

FAX _____
Telephone (303) 740-2791

Sampling Collection and Shipment

Sampling Site _____ Date of Collection July 16, 1991Date Samples Received at DataChem July 22, 1991

Analysis

Method of Analysis GC/FIDDate(s) of Analysis July 24, 1991

Analytical Results

Field Sample Number	DataChem Lab Number	Sample Type	Trichloroethylene mg/sample 'A' SECTION	Trichloroethylene mg/sample 'B' SECTION							
VESP5A071691	CL 14995	CT	0.06	ND*							
VESP5B071691	CL 14996	CT	0.14	ND*							
VESP5C071691	CL 14997	CT	0.16	ND*							
VESP6A071691	CL 14998	CT	0.13	ND*							
VESP6B071691	CL 14999	CT	0.17	ND*							
VESP6C071691	CL 15000	CT	0.12	ND*							
VESP7A071691	CL 15001	CT	0.23	ND*							
VESP7B071691	CL 15002	CT	0.21	ND*							
VESP7C071691	CL 15003	CT	0.17	ND*							
VESP8A071691	CL 15004	CT	0.09	ND*							
VESP8B071691	CL 15005	CT	0.09	ND*							
VESP8C071691	CL 15006	CT	0.02	ND*							
VES-1000-P	CL 15007	CT	0.22	ND*							

See comment on last page.
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** See comment on last page.
() Parameter between LOD and LOQ.

Analyst: Amy J. Jensen

Reviewer: Pamela Johnson

Laboratory Supervisor: Daniel J. Bruch

960 West LeVoy Drive / Salt Lake City, Utah 84123-2547 / (801) 266-7700
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ANALYTICAL REPORT

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AUG 12 1991

Page 1 of 2

Part 1 of 1

WCC/DENVER, COLORADO

Date 8/8/91Agency Identification Number 91-2024Account No. 03019

Woodward-Clyde Consultants
4582 South Ulster Street Parkway
Standford Place 3, Suite 1000
Denver, CO 80237
Attention: Jeff Cox

FAX _____
Telephone (303) 740-2791

Sampling Collection and Shipment

Sampling Site _____ Date of Collection July 24, 1991Date Samples Received at DataChem July 26, 1991

Analysis

Method of Analysis NIOSH 1022Date(s) of Analysis July 31, 1991

Analytical Results

Field Sample Number	DataChem Lab Number	Sample Type	Trichloro ethylene MG/SAMPLE A SECTION	Trichloro ethylene MG/SAMPLE B SECTION						
VES5A072491P	CL 15626	CT	0.01	ND*						
VES5B072491P	CL 15627	CT	0.03	ND*						
VES5C072491P	CL 15628	CT	0.07	ND*						
VES6A072491P	CL 15629	CT	0.03	ND*						
VES6B072491P	CL 15630	CT	0.07	ND*						
VES6C072491P	CL 15631	CT	0.19	ND*						
VES7A072491P	CL 15632	CT	ND*	ND*						
VES7B072491P	CL 15633	CT	0.14	ND*						
VES7C072491P	CL 15634	CT	0.08	ND*						
VES8A072491P	CL 15635	CT	ND*	ND*						
VES8B072491P	CL 15636	CT	0.04	ND*						
VES8C072491P	CL 15637	CT	ND*	ND*						
VES3072491P	CL 15638	CT	0.10	ND*						

† See comment on last page.
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NR Parameter not requested.

** See comment on last page.
() Parameter between LOD and LOQ.

F. Rejali
Analyst: Fred M. Rejali

Dan Bruch
Reviewer: Daniel J. Bruch

Dan Bruch
Laboratory Supervisor: Daniel J. Bruch

960 West LeVoy Drive / Salt Lake City, Utah 84123-2547 / (801) 266-7700
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WCC/DENVER, COLORADO

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Part 1 of 1

Date 8/23/91Agency Identification Number 91-2162Account No. 03019

Woodward-Clyde Consultants
4582 South Ulster Street Parkway
Standford Place 3, Suite 1000
Denver, CO 80237
Attention: Jeff Cox

FAX _____
Telephone (303) 740-2791

Sampling Collection and Shipment

Sampling Site _____ Date of Collection July 29, 1991Date Samples Received at DataChem August 06, 1991

Analysis

Method of Analysis NIOSH 1003, NIOSH 1007, NIOSH 1022Date(s) of Analysis August 15, 1991

Analytical Results

Field Sample Number	DataChem Lab Number	Sample Type	Trichloroethylene mg/sample GC/FID	1,2-Dichloroethene mg/sample GC/FID	Vinyl Chloride mg/sample GC/FID						
5A-072991-P	CL 17099	CT	ND*	ND*	ND*						
5B-072991-P	CL 17100	CT	0.02	ND*	ND*						
5C-072991-P	CL 17101	CT	ND*	ND*	ND*						
6A-072991-P	CL 17102	CT	0.01	ND*	ND*						
6B-072991-P	CL 17103	CT	0.03	ND*	ND*						
6C-072991-P	CL 17104	CT	0.02	ND*	ND*						
7A-072991-P	CL 17105	CT	ND*	ND*	ND*						
7B-072991-P	CL 17106	CT	0.03	ND*	ND*						
7C-072991-P	CL 17107	CT	0.02	ND*	ND*						
8A-072991-P	CL 17108	CT	ND*	ND*	ND*						
8B-072991-P	CL 17109	CT	0.03	ND*	ND*						
8C-072991-P	CL 17110	CT	ND*	ND*	ND*						
DIS-072991-P	CL 17111	CT	ND*	ND*	ND*						

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() Parameter between LOD and LOQ.

Jeff R. Scott
Analyst: Jeff R. Scott

F. Rejali
Reviewer: Fred M. Rejali

Daniel J. Bruch
Laboratory Supervisor: Daniel J. Bruch

960 West LeVoy Drive / Salt Lake City, Utah 84123-2547 / (801) 266-7700
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ANALYTICAL REPORT

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Page 2 of 4

Part 1 of 1

Date 8/23/01Agency Identification Number 91-2162

Analytical Results

Field Sample Number	DataChem Lab Number	Sample Type	Trichloro ethylene mg/sample GC/FID	1,2-Dichloro ethene mg/sample GC/FID	Vinyl Chloride mg/sample GC/FID						
VES4072991-P	CL 17112	CT	0.17	ND*	ND*						
VES-2000-P	CL 17113	CT	ND*	ND*	ND*						
VES-2001	CL 17114	CT	ND*	ND*	ND*						
5A-073191-P	CL 17115	CT	ND*	ND*	ND*						
5B-073191-P	CL 17116	CT	0.01	ND*	ND*						
5C-073191-P	CL 17117	CT	0.04	ND*	ND*						
6A-073191-P	CL 17118	CT	ND*	ND*	ND*						
6B-073191-P	CL 17119	CT	0.02	ND*	ND*						
6C-073191-P	CL 17120	CT	ND*	ND*	ND*						
7A-073191-P	CL 17121	CT	ND*	ND*	ND*						
7B-073191-P	CL 17122	CT	ND*	ND*	ND*						
7C-073191-P	CL 17123	CT	0.03	ND*	ND*						
8A-073191-P	CL 17124	CT	ND*	ND*	ND*						
8B-073191-P	CL 17125	CT	0.03	ND*	ND*						
8C-073191-P	CL 17126	CT	0.03	ND*	ND*						
DIS-073191-P	CL 17127	CT	ND*	ND*	ND*						
VES4073191-P	CL 17128	CT	0.19	ND*	ND*						
VES-2002-P	CL 17129	CT	0.03	ND*	ND*						
VES-2003	CL 17130	CT	ND*	ND*	ND*						
5A-080291-P	CL 17131	CT	ND*	ND*	ND*						
5B-080291-P	CL 17132	CT	ND*	ND*	ND*						
5C-080291-P	CL 17133	CT	0.01	ND*	ND*						
6A-080291-P	CL 17134	CT	ND*	ND*	ND*						
6B-080291-P	CL 17135	CT	0.02	ND*	ND*						
6C-080291-P	CL 17136	CT	0.02	ND*	ND*						
7A-080291-P	CL 17137	CT	ND*	ND*	ND*						
7B-080291-P	CL 17138	CT	ND*	ND*	ND*						
7C-080291-P	CL 17139	CT	0.02	ND*	ND*						
8A-080291-P	CL 17140	CT	ND*	ND*	ND*						
8B-080291-P	CL 17141	CT	0.03	ND*	ND*						

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Date 8/23/91

Agency Identification Number 91-2162

Sample Comments

DataChem Lab
Number

-- Comment --

CL 17135

B-SECTION CONTAINED >30% OF REPORTED AMOUNT OF TRICHLOROETHYLENE.



ANALYTICAL REPORT

Form ARF-AL

Page 1 of 2

Part 1 of 1

AUG 28 1991

WCC/DENVER, COLORADO

Date 8/23/91Agency Identification Number 91-2217Account No. 03019

Woodward-Clyde Consultants
4582 South Ulster Street Parkway
Stanford Place 3, Suite 1000
Denver, CO 80237
Attention: Rich Scheig

FAX _____
Telephone (303) 694-2770

Sampling Collection and Shipment

Sampling Site _____ Date of Collection August 07, 1991Date Samples Received at DataChem August 09, 1991

Analysis

Method of Analysis NIOSH 1003, NIOSH 1007, NIOSH 1022Date(s) of Analysis August 16, 1991

Analytical Results

Field Sample Number	DataChem Lab Number	Sample Type	Trichloro ethylene mg/sample GC/FID	1,2-Dichloro ethene mg/sample GC/FID	Vinyl Chloride mg/sample GC/FID					
VES5A080791P	CL 17746	CT	ND*	ND*	ND*					
VES5B080791P	CL 17747	CT	ND*	ND*	ND*					
VES5C080791P	CL 17748	CT	0.01	ND*	ND*					
VES6A080791P	CL 17749	CT	ND*	ND*	ND*					
VES6B080791P	CL 17750	CT	0.02	ND*	ND*					
VES6C080791P	CL 17751	CT	0.02	ND*	ND*					
VES7A080791P	CL 17752	CT	ND*	ND*	ND*					
VES7B080791P	CL 17753	CT	ND*	ND*	ND*					
VES7C080791P	CL 17754	CT	0.02	ND*	ND*					
VES8A080791P	CL 17755	CT	ND*	ND*	ND*					
VES8B080791P	CL 17756	CT	0.04	ND*	ND*					
VES8C080791P	CL 17757	CT	0.11	ND*	ND*					
VES4080791-P	CL 17758	CT	0.08	ND*	ND*					

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Jeff R. Scott
Analyst: Jeff R. Scott

F. Rejali
Reviewer: Fred M. Rejali

Daniel J. Bruch
Laboratory Supervisor: Daniel J. Bruch

960 West LeVoy Drive / Salt Lake City, Utah 84123-2547 / (801) 266-7700
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WCC/DENVER, COLORADO

Date

8/30/91

Agency Identification Number 91-2499

Account No. 03019

Woodward-Clyde Consultants
4582 South Ulster Street Parkway
Stanford Place 3, Suite 1000
Denver, CO 80237
Attention: Rich Scheig

FAX
Telephone (303) 694-2770

Sampling Collection and Shipment

Sampling Site _____ Date of Collection August 12, 1991

Date Samples Received at DataChem August 14, 1991

Analysis

Method of Analysis NIOSH 1003, NIOSH 1007, NIOSH 1022

Date(s) of Analysis August 26, 1991

Analytical Results

Field Sample Number	DataChem Lab Number	Sample Type	Trichloro ethylene mg/sample GC/FID	1,2-Dichloro ethylene mg/sample GC/FID	Vinyl Chloride mg/sample GC/FID					
VES5A081291P	CL 18144	CT	ND*	ND*	ND*					
VES5B081291P	CL 18145	CT	ND*	ND*	ND*					
VES5C081291P	CL 18146	CT	0.04	ND*	ND*					
VES6A081291P	CL 18147	CT	ND*	ND*	ND*					
VES6B081291P	CL 18148	CT	ND*	ND*	ND*					
VES6C081291P	CL 18149	CT	ND*	ND*	ND*					
VES7A081291P	CL 18150	CT	ND*	ND*	ND*					
VES7B081291P	CL 18151	CT	ND*	ND*	ND*					
VES7C081291P	CL 18152	CT	ND*	ND*	ND*					
VES8A081291P	CL 18153	CT	ND*	ND*	ND*					
VES8B081291P	CL 18154	CT	ND*	ND*	ND*					
VES8C081291P	CL 18155	CT	0.03	ND*	ND*					
DIS-081291-P	CL 18156	CT	ND*	ND*	ND*					

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() Parameter between LOD and LOQ.

Analyst: Jeff R. Scott

Reviewer: Fred M. Rejali

Laboratory Supervisor: Daniel J. Bruch

960 West LeVoy Drive / Salt Lake City, Utah 84123-2547 / (801) 266-7700
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**DATA
CHEM**
LABORATORIES

SEP 8 1991

WOODWARD, COLORADO

Date 9/5/91Agency Identification Number 91-2630Account No. 03019

Woodward-Clyde Consultants
4582 South Ulster Street Parkway
Stanford Place 3, Suite 1000
Denver, CO 80237
Attention: Rich Scheig

FAX _____
Telephone (303) 694-2770

Sampling Collection and Shipment

Sampling Site _____ Date of Collection August 19, 1991Date Samples Received at DataChem August 26, 1991

Analysis

Method of Analysis NIOSH 1003, NIOSH 1007, NIOSH 1022Date(s) of Analysis August 30, 1991

Analytical Results

Field Sample Number	DataChem Lab Number	Sample Type	Trichloro ethylene MG/SAMPLE GC/FID	1,2-Dichloro ethylene MG/SAMPLE GC/FID	Vinyl Chloride MG/SAMPLE GC/FID						
5A-081991-P	CL 19351	CT	ND*	ND*	ND*						
5B-081991-P	CL 19352	CT	0.01	ND*	ND*						
5C-081991-P	CL 19353	CT	ND*	ND*	ND*						
6A-081991-P	CL 19354	CT	ND*	ND*	ND*						
6B-081991-P	CL 19355	CT	0.01	ND*	ND*						
6C-081991-P	CL 19356	CT	0.04	ND*	ND*						
7A-081991-P	CL 19357	CT	ND*	ND*	ND*						
7B-081991-P	CL 19358	CT	0.03	ND*	ND*						
7C-081991-P	CL 19359	CT	0.03	ND*	ND*						
8A-081991-P	CL 19360	CT	ND*	ND*	ND*						
8B-081991-P	CL 19361	CT	0.01	ND*	ND*						
8C-081991-P	CL 19362	CT	0.03	ND*	ND*						
VES3081991P	CL 19363	CT	0.05	ND*	ND*						

* See comment on last page.
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** See comment on last page.
() Parameter between LOD and LOQ.

F. Rejali
Analyst: Fred M. Rejali

Jeff R. Scott
Reviewer: Jeff R. Scott

Dan Bruch
Laboratory Supervisor: Daniel J. Bruch

960 West LeVoy Drive / Salt Lake City, Utah 84123-2547 / (801) 266-7700
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Date 9/17/91Agency Identification Number 91-2715Account No. 03019

Woodward-Clyde Consultants
4582 South Ulster Street Parkway
Stanford Place 3, Suite 1000
Denver, CO 80237
Attention: Rich Scheig

FAX _____
Telephone (303) 694-2770

Sampling Collection and Shipment

Sampling Site _____ Date of Collection August 26, 1991Date Samples Received at DataChem September 03, 1991

Analysis

Method of Analysis NIOSH 1003, NIOSH 1007, NIOSH 1022Date(s) of Analysis September 12, 1991

Analytical Results

Field Sample Number	DataChem Lab Number	Sample Type	Trichloro ethylene MG/SAMPLE GC/FID	1,2-Dichloro ethylene MG/SAMPLE GC/FID	Vinyl Chloride MG/SAMPLE GC/FID					
VES5A082691P	CL 20127	CT	ND*	ND*	ND*					
VES5B082691P	CL 20128	CT	0.03	ND*	ND*					
VES5C082691P	CL 20129	CT	0.01	ND*	ND*					
VES6A082691P	CL 20130	CT	ND*	ND*	ND*					
VES6B082691P	CL 20131	CT	0.02	ND*	ND*					
VES6C082691P	CL 20132	CT	ND*	ND*	ND*					
VES7A082691P	CL 20133	CT	ND*	ND*	ND*					
VES7B082691P	CL 20134	CT	0.02	ND*	ND*					
VES7C082691P	CL 20135	CT	ND*	ND*	ND*					
VES8A082691P	CL 20136	CT	ND*	ND*	ND*					
VES8B082691P	CL 20137	CT	0.02	ND*	ND*					
VES8C082691P	CL 20138	CT	ND*	ND*	ND*					
VES3082691P	CL 20139	CT	0.05	ND*	ND*					

* See comment on last page.

ND Parameter not detected.

NR Parameter not requested.

** See comment on last page.
() Parameter between LOD and LOQ.Analyst: F. Rejali
Fred M. RejaliReviewer: Jeff R. Scott
Jeff R. ScottLaboratory Supervisor: Daniel J. Bruch
Daniel J. Bruch

960 West LeVoy Drive / Salt Lake City, Utah 84123-2547 / (801) 266-7700
A Sorenson Company



ANALYTICAL REPORT

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Page 1 of 2

Part 1 of 1

Date 9/17/91
Agency Identification Number 91-2776
Account No. 03019

Woodward-Clyde Consultants
4582 South Ulster Street Parkway
Stanford Place 3, Suite 1000
Denver, CO 80237
Attention: Rich Scheig

FAX _____
Telephone (303) 694-2770

Sampling Collection and Shipment

Sampling Site _____ Date of Collection September 03, 1991Date Samples Received at DataChem September 05, 1991

Analysis

Method of Analysis NIOSH 1003, NIOSH 1007, NIOSH 1022Date(s) of Analysis September 12, 1991

Analytical Results

Field Sample Number	DataChem Lab Number	Sample Type	Trichloro ethylene MG/SAMPLE GC/FID	1,2-Dichloro ethylene MG/SAMPLE GC/FID	Vinyl Chloride MG/SAMPLE GC/FID					
5A-090391-P	CL 20593	CT	ND*	ND*	ND*					
5B-090391-P	CL 20594	CT	0.01	ND*	ND*					
5C-090391-P	CL 20595	CT	0.02	ND*	ND*					
6A-090391-P	CL 20596	CT	ND*	ND*	ND*					
6B-090391-P	CL 20597	CT	ND*	ND*	ND*					
6C-090391-P	CL 20598	CT	0.01	ND*	ND*					
7A-090391-P	CL 20599	CT	ND*	ND*	ND*					
7B-090391-P	CL 20600	CT	ND*	ND*	ND*					
7C-090391-P	CL 20601	CT	0.11	ND*	ND*					
8A-090391-P	CL 20602	CT	ND*	ND*	ND*					
8B-090391-P	CL 20603	CT	0.01	ND*	ND*					
8C-090391-P	CL 20604	CT	ND*	ND*	ND*					
DIS-090391-P	CL 20605	CT	ND*	ND*	ND*					

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() Parameter between LOD and LOQ.

F. Rejali
Analyst: Fred M. Rejali

Jeff R. Scott
Reviewer: Jeff R. Scott

Dan Bruch
Laboratory Supervisor: Daniel J. Bruch

960 West LeVoy Drive / Salt Lake City, Utah 84123-2547 / (801) 266-7700
A Sorenson Company



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Date 9/17/91
Agency Identification Number 91-2824
Account No. 03019

Woodward-Clyde Consultants
4582 South Ulster Street Parkway
Stanford Place 3, Suite 1000
Denver, CO 80237
Attention: Rich Scheig

FAX _____
Telephone (303) 694-2770

Sampling Collection and Shipment

Sampling Site _____ Date of Collection September 09, 1991Date Samples Received at DataChem September 10, 1991

Analysis

Method of Analysis NIOSH 1003, NIOSH 1007, NIOSH 1022Date(s) of Analysis September 12, 1991

Analytical Results

Field Sample Number	DataChem Lab Number	Sample Type	Trichloroethylene MG/SAMPLE GC/FID	1,2-Dichloroethylene MG/SAMPLE GC/FID	Vinyl Chloride MG/SAMPLE GC/FID				
5A-090991-B	CL 20879	CT	ND*	ND*	ND*				
5B-090991-B	CL 20880	CT	ND*	ND*	ND*				
5C-090991-B	CL 20881	CT	ND*	ND*	ND*				
6A-090991-B	CL 20882	CT	ND*	ND*	ND*				
6B-090991-B	CL 20883	CT	ND*	ND*	ND*				
6C-090991-B	CL 20884	CT	ND*	ND*	ND*				
7A-090991-B	CL 20885	CT	ND*	ND*	ND*				
7B-090991-B	CL 20886	CT	ND*	ND*	ND*				
7C-090991-B	CL 20887	CT	ND*	ND*	ND*				
8A-090991-B	CL 20888	CT	ND*	ND*	ND*				
8B-090991-B	CL 20889	CT	ND*	ND*	ND*				
8C-090991-B	CL 20890	CT	ND*	ND*	ND*				
DIS-090991-B	CL 20891	CT	ND*	ND*	ND*				

See comment on last page.
ND Parameter not detected.
NR Parameter not requested.

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() Parameter between LOD and LOQ.

F. Rejali
Analyst: Fred M. Rejali

JEFF R. SCOTT
Reviewer: Jeff R. Scott

Dan Bruch
Laboratory Supervisor: Daniel J. Bruch

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Date 9/23/91Agency Identification Number 91-2912Account No. 03019

Woodward-Clyde Consultants
4582 South Ulster Street Parkway
Stanford Place 3, Suite 1000
Denver, CO 80237
Attention: Rich Scheig

FAX _____
Telephone (303) 694-2770

Sampling Collection and Shipment

Sampling Site _____ Date of Collection September 16, 1991Date Samples Received at DataChem September 17, 1991

Analysis

Method of Analysis NIOSH 1003, NIOSH 1007, NIOSH 1022Date(s) of Analysis September 20, 1991

Analytical Results

Field Sample Number	DataChem Lab Number	Sample Type	Trichloroethylene MG/SAMPLE GC/FID	1,2-Dichloroethylene MG/SAMPLE GC/FID	Vinyl Chloride MG/SAMPLE GC/FID					
5A-091691-P	CL 21465	CT	ND*	ND*	ND*					
5B-091691-P	CL 21466	CT	ND*	ND*	ND*					
5C-091691-P	CL 21467	CT	ND*	ND*	ND*					
6A-091691-P	CL 21468	CT	ND*	ND*	ND*					
6B-091691-P	CL 21469	CT	ND*	ND*	ND*					
6C-091691-P	CL 21470	CT	ND*	ND*	ND*					
7A-091691-P	CL 21471	CT	ND*	ND*	ND*					
7B-091691-P	CL 21472	CT	ND*	ND*	ND*					
7C-091691-P	CL 21473	CT	ND*	ND*	ND*					
8A-091691-P	CL 21474	CT	ND*	ND*	ND*					
8B-091691-P	CL 21475	CT	ND*	ND*	ND*					
8C-091691-P	CL 21476	CT	ND*	ND*	ND*					
VES4-091691-P	CL 21477	CT	0.07	ND*	ND*					

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() Parameter between LOD and LOQ.

F. Rejali
Analyst: Fred M. Rejali

Jeff R. Scott
Reviewer: Jeff R. Scott

Dan Bruch
Laboratory Supervisor: Daniel J. Bruch

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Date 10/8/91
Agency Identification Number 91-2985
Account No. 03019

Woodward-Clyde Consultants
4582 South Ulster Street Parkway
Stanford Place 3, Suite 1000
Denver, CO 80237
Attention: Rich Scheig

FAX _____
Telephone (303) 694-2770

Sampling Collection and Shipment

Sampling Site _____ Date of Collection September 20, 1991Date Samples Received at DataChem September 24, 1991

Analysis

Method of Analysis NIOSH 1003, NIOSH 1007, NIOSH 1022Date(s) of Analysis September 28, 1991

Analytical Results

Field Sample Number	DataChem Lab Number	Sample Type	Trichloro ethylene mg/sample GC/FID	1,2-Dichloro ethylene mg/sample GC/FID	Vinyl Chloride mg/sample GC/FID					
5A-092091-P	CL 21942	CT	ND*	ND*	ND*					
5B-092091-P	CL 21943	CT	ND*	ND*	ND*					
5C-092091-P	CL 21944	CT	ND*	ND*	ND*					
6A-092091-P	CL 21945	CT	ND*	ND*	ND*					
6B-092091-P	CL 21946	CT	ND*	ND*	ND*					
6C-092091-P	CL 21947	CT	0.02	ND*	ND*					
7A-092091-P	CL 21948	CT	ND*	ND*	ND*					
7B-092091-P	CL 21949	CT	ND*	ND*	ND*					
8A-092091-P	CL 21950	CT	ND*	ND*	ND*					
8B-092091-P	CL 21951	CT	0.01	ND*	ND*					
8C-092091-P	CL 21952	CT	ND*	ND*	ND*					
7C-092091-P	CL 21953	CT	0.03	ND*	ND*					
VES-5006-P	CL 21954	CT	ND*	ND*	ND*					

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() Parameter between LOD and LOQ.

F. Rejali
Analyst: Fred M. Rejali

Jeff R. Scott
Reviewer: Jeff R. Scott

Dan Bruch
Laboratory Supervisor: Daniel J. Bruch

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Date 10/8/91
Agency Identification Number 91-3022
Account No. 03019

Woodward-Clyde Consultants
4582 South Ulster Street Parkway
Stanford Place 3, Suite 1000
Denver, CO 80237
Attention: Rich Scheig

FAX _____
Telephone (303) 694-2770

Sampling Collection and Shipment

Sampling Site _____ Date of Collection September 23, 1991Date Samples Received at DataChem September 27, 1991

Analysis

Method of Analysis NIOSH 1003, NIOSH 1007, NIOSH 1022Date(s) of Analysis September 28, 1991

Analytical Results

Field Sample Number	DataChem Lab Number	Sample Type	Trichloro ethylene mg/sample GC/FID	1,2-Dichloro ethylene mg/sample GC/FID	Vinyl Chloride mg/sample GC/FID					
5A-092391-P	CL 22260	CT	ND*	ND*	ND*					
5B-092391-P	CL 22261	CT	0.02	ND*	ND*					
5C-092391-P	CL 22262	CT	0.02	ND*	ND*					
6A-092391-P	CL 22263	CT	ND*	ND*	ND*					
6B-092391-P	CL 22264	CT	ND*	ND*	ND*					
6C-092391-P	CL 22265	CT	0.04	ND*	ND*					
7A-092391-P	CL 22266	CT	ND*	ND*	ND*					
7B-092391-P	CL 22267	CT	ND*	ND*	ND*					
7C-092391-P	CL 22268	CT	ND*	ND*	ND*					
8A-092391-P	CL 22269	CT	ND*	ND*	ND*					
8B-092391-P	CL 22270	CT	0.01	ND*	ND*					
8C-092391-P	CL 22271	CT	0.03	ND*	ND*					
VES3-092391P	CL 22272	CT	0.10	ND*	ND*					

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() Parameter between LOD and LOQ.

F. Rejali
Analyst: Fred M. Rejali

Jeff R. Scott
Reviewer: Jeff R. Scott

Dan Bruch
Laboratory Supervisor: Daniel J. Bruch

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Date 10/11/91Agency Identification Number 91-3087Account No. 03019

Woodward-Clyde Consultants
4582 South Ulster Street Parkway
Stanford Place 3, Suite 1000
Denver, CO 80237
Attention: Rich Scheig

FAX _____
Telephone (303) 694-2770

Sampling Collection and Shipment

Sampling Site _____ Date of Collection October 01, 1991Date Samples Received at DataChem October 03, 1991

Analysis

Method of Analysis NIOSH 1003, NIOSH 1007, NIOSH 1022Date(s) of Analysis October 06, 1991 - October 07, 1991

Analytical Results

Field Sample Number	DataChem Lab Number	Sample Type	Trichloro ethylene MG/SAMPLE GC/FID	1,2-dichloro ethylene MG/SAMPLE GC/FID	Vinyl Chloride MG/SAMPLE GC/FID					
5A-100191-P	CL 22904	CT	ND*	ND*	ND*					
5B-100191-P	CL 22905	CT	0.03	ND*	ND*					
5C-100191-P	CL 22906	CT	0.07	ND*	ND*					
6A-100191-P	CL 22907	CT	ND*	ND*	ND*					
6B-100191-P	CL 22908	CT	0.04	ND*	ND*					
6C-100191-P	CL 22909	CT	0.11	ND*	ND*					
7A-100191-P	CL 22910	CT	ND*	ND*	ND*					
7B-100191-P	CL 22911	CT	0.04	ND*	ND*					
7C-100191-P	CL 22912	CT	0.09	ND*	ND*					
8A-100191-P	CL 22913	CT	ND*	ND*	ND*					
8B-100191-P	CL 22914	CT	0.03	ND*	ND*					
8C-100191-P	CL 22915	CT	ND*	ND*	ND*					
VES-5010-P	CL 22916	CT	0.08	ND*	ND*					

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F. Rejali
Analyst: Fred M. Rejali

Jeff R. Scott
Reviewer: Jeff R. Scott

Dan Bruch
Laboratory Supervisor: Daniel J. Bruch

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Date 10/15/91Agency Identification Number 91-3141Account No. 03019

Woodward-Clyde Consultants
4582 South Ulster Street Parkway
Stanford Place 3, Suite 1000
Denver, CO 80237
Attention: Rich Scheig

FAX _____
Telephone (303) 694-2770

Sampling Collection and Shipment

Sampling Site _____ Date of Collection October 07, 1991Date Samples Received at DataChem October 08, 1991

Analysis

Method of Analysis NIOSH 1003, NIOSH 1007, NIOSH 1022Date(s) of Analysis October 12, 1991 - October 13, 1991

Analytical Results

Field Sample Number	DataChem Lab Number	Sample Type	Trichloro ethylene MG/SAMPLE GC/FID	1,2-Dichloro ethylene MG/SAMPLE GC/FID	Vinyl Chloride MG/SAMPLE GC/FID					
5A-100791-F	CL 23344	CT	ND*	ND*	ND*					
5B-100791-F	CL 23345	CT	0.04	ND*	ND*					
5C-100791-F	CL 23346	CT	0.02	ND*	ND*					
6A-100791-F	CL 23347	CT	ND*	ND*	ND*					
6B-100791-F	CL 23348	CT	0.05	ND*	ND*					
6C-100791-F	CL 23349	CT	0.08	ND*	ND*					
7A-100791-F	CL 23350	CT	ND*	ND*	ND*					
7B-100791-F	CL 23351	CT	0.06	ND*	ND*					
7C-100791-F	CL 23352	CT	0.13	ND*	ND*					
8A-100791-F	CL 23353	CT	ND*	ND*	ND*					
8B-100791-F	CL 23354	CT	0.03	ND*	ND*					
8C-100791-F	CL 23355	CT	0.09	ND*	ND*					
VES3100791-F	CL 23356	CT	0.09	ND*	ND*					

See comment on last page.
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F. Rejali
Analyst: Fred M. Rejali

Jeff R. Scott
Reviewer: Jeff R. Scott

Dan Bruch
Laboratory Supervisor: Daniel J. Bruch

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Date 10/24/91
Agency Identification Number 91-3229
Account No. 03019

Woodward-Clyde Consultants
4582 South Ulster Street Parkway
Stanford Place 3, Suite 1000
Denver, CO 80237
Attention: Rich Scheig

FAX _____
Telephone (303) 694-2770

Sampling Collection and Shipment

Sampling Site _____ Date of Collection October 11, 1991Date Samples Received at DataChem October 16, 1991

Analysis

Method of Analysis NIOSH 1003, NIOSH 1007, NIOSH 1022Date(s) of Analysis October 20, 1991

Analytical Results

Field Sample Number	DataChem Lab Number	Sample Type	Trichloroethylene MG/SAMPLE GC/FID	1,2-Dichloroethylene MG/SAMPLE GC/FID	Vinyl Chloride MG/SAMPLE GC/FID					
5A-101191-P	CL 24395	CT	ND*	ND*	ND*					
5B-101191-P	CL 24396	CT	0.03	ND*	ND*					
5C-101191-P	CL 24397	CT	0.09	ND*	ND*					
6A-101191-P	CL 24398	CT	ND*	ND*	ND*					
6B-101191-P	CL 24399	CT	0.04	ND*	ND*					
6C-101191-P	CL 24400	CT	0.12	ND*	ND*					
7A-101191-P	CL 24401	CT	ND*	ND*	ND*					
7B-101191-P	CL 24402	CT	0.04	ND*	ND*					
7C-101191-P	CL 24403	CT	0.11	ND*	ND*					
8A-101191-P	CL 24404	CT	ND*	ND*	ND*					
8B-101191-P	CL 24405	CT	ND*	ND*	ND*					
8C-101191-P	CL 24406	CT	0.09	ND*	ND*					
VES-5014-P	CL 24407	CT	0.12	ND*	ND*					

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() Parameter between LOD and LOQ.

Analyst: F. RejaliReviewer: Jeff R. ScottLaboratory Supervisor: Daniel J. Bruch

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Date 10/24/91
Agency Identification Number 91-3230
Account No. 03019

Woodward-Clyde Consultants
4582 South Ulster Street Parkway
Stanford Place 3, Suite 1000
Denver, CO 80237
Attention: Rich Scheig

FAX _____
Telephone (303) 694-2770

Sampling Collection and Shipment

Sampling Site _____ Date of Collection October 15, 1991Date Samples Received at DataChem October 16, 1991

Analysis

Method of Analysis NIOSH 1003, NIOSH 1007, NIOSH 1022Date(s) of Analysis October 20, 1991

Analytical Results

Field Sample Number	DataChem Lab Number	Sample Type	Trichloroethylene MG/SAMPLE GC/FID	1,2-Dichloroethylene MG/SAMPLE GC/FID	Vinyl Chloride MG/SAMPLE GC/FID					
5A-101591-P	CL 24410	CT	ND*	ND*	ND*					
5B-101591-P	CL 24411	CT	0.02	ND*	ND*					
5C-101591-P	CL 24412	CT	0.04	ND*	ND*					
6A-101591-P	CL 24413	CT	ND*	ND*	ND*					
6B-101591-P	CL 24414	CT	0.02	ND*	ND*					
6C-101591-P	CL 24415	CT	0.07	ND*	ND*					
7A-101591-P	CL 24416	CT	ND*	ND*	ND*					
7B-101591-P	CL 24417	CT	0.02	ND*	ND*					
7C-101591-P	CL 24418	CT	ND*	ND*	ND*					
8A-101591-P	CL 24419	CT	ND*	ND*	ND*					
8B-101591-P	CL 24420	CT	0.02	ND*	ND*					
8C-101591-P	CL 24421	CT	0.12	ND*	ND*					
DIS-101591-P	CL 24422	CT	ND*	ND*	ND*					

* See comment on last page.
ND Parameter not detected.
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() Parameter between LOD and LOQ.

Analyst: F. RejzliReviewer: Jeff R. ScottLaboratory Supervisor: Daniel J. Bruch

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Date 11/1/91
Agency Identification Number 91-3369
Account No. 03019

Woodward-Clyde Consultants
4582 South Ulster Street Parkway
Stanford Place 3, Suite 1000
Denver, CO 80237
Attention: Rich Scheig

FAX _____
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Sampling Collection and Shipment

Sampling Site _____ Date of Collection October 21, 1991Date Samples Received at DataChem October 25, 1991

Analysis

Method of Analysis GC/FIDDate(s) of Analysis October 28, 1991

Analytical Results

Field Sample Number	DataChem Lab Number	Sample Type	Trichloroethylene mg/sample							
5A-102191-P	CL 25551	CT	ND*							
5B-102191-P	CL 25552	CT	ND*							
5C-102191-P	CL 25553	CT	0.03							
6A-102191-P	CL 25554	CT	ND*							
6B-102191-P	CL 25555	CT	ND*							
6C-102191-P	CL 25556	CT	ND*							
7A-102191-P	CL 25557	CT	ND*							
7B-102191-P	CL 25558	CT	ND*							
7C-102191-P	CL 25559	CT	ND*							
8A-102191-P	CL 25560	CT	ND*							
8B-102191-P	CL 25561	CT	ND*							
8C-102191-P	CL 25562	CT	ND*							
DIS-102191-P	CL 25563	CT	ND*							

See comment on last page.
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() Parameter between LOD and LOQ.

Young Hee Yoon
Analyst: Young Hee Yoon

Don Buch
Reviewer:

Don Buch
Laboratory Supervisor:



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Part 1 of 1

Date 11/1/91
Agency Identification Number 91-3395
Account No. 03019

Woodward-Clyde Consultants
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Stanford Place 3, Suite 1000
Denver, CO 80237
Attention: Rich Scheig

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Sampling Collection and Shipment

Sampling Site _____ Date of Collection October 28, 1991Date Samples Received at DataChem October 29, 1991

Analysis

Method of Analysis GC/FIDDate(s) of Analysis October 30, 1991

Analytical Results

Field Sample Number	DataChem Lab Number	Sample Type	Trichloroethylene mg/sample							
5A-102891-P	CL 25734	CT	ND*							
5B-102891-P	CL 25735	CT	ND*							
5C-102891-P	CL 25736	CT	ND*							
6A-102891-P	CL 25737	CT	ND*							
6B-102891-P	CL 25738	CT	ND*							
6C-102891-P	CL 25739	CT	ND*							
7A-102891-P	CL 25740	CT	ND*							
7B-102891-P	CL 25741	CT	ND*							
7C-102891-P	CL 25742	CT	ND*							
8A-102891-P	CL 25743	CT	ND*							
8B-102891-P	CL 25744	CT	0.02							
8C-102891-P	CL 25745	CT	ND*							
VES4-102891P	CL 25746	CT	0.07							

- See comment on last page.
ND Parameter not detected.
NR Parameter not requested.

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() Parameter between LOD and LOQ.

Analyst: Young Hae YoonReviewer: Dan BruchLaboratory Supervisor: Dan Bruch

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Woodward-Clyde Consultants
4582 South Ulster Street Parkway
Stanford Place 3, Suite 1000
Denver, CO 80237
Attention: Rich Scheig

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Sampling Collection and Shipment

Sampling Site _____ Date of Collection November 01, 1991

Date Samples Received at DataChem November 04, 1991

Analysis

Method of Analysis NIOSH 1022

Date(s) of Analysis November 06, 1991

Analytical Results

Field Sample Number	DataChem Lab Number	Sample Type	Trichloroethylene mg/sample							
5A-110191-P	CL 26158	CT	ND*							
5B-110191-P	CL 26159	CT	ND*							
5C-110191-P	CL 26160	CT	ND*							
6A-110191-P	CL 26161	CT	ND*							
6B-110191-P	CL 26162	CT	ND*							
6C-110191-P	CL 26163	CT	ND*							
7A-110191-P	CL 26164	CT	ND*							
7B-110191-P	CL 26165	CT	ND*							
7C-110191-P	CL 26166	CT	ND*							
8A-110191-P	CL 26167	CT	ND*							
8B-110191-P	CL 26168	CT	ND*							
8C-110191-P	CL 26169	CT	ND*							
VES-5022-P	CL 26170	CT	ND*							

See comment on last page.
ND Parameter not detected.
NR Parameter not requested.

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() Parameter between LOD and LOQ.

Analyst: Lawrence E. Miller

Reviewer: Dan Bruch

Laboratory Supervisor: Dan Bruch

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Date 11/18/91
Agency Identification Number 91-3494
Account No. 03019

Woodward-Clyde Consultants
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Stanford Place 3, Suite 1000
Denver, CO 80237
Attention: Rich Scheig

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Sampling Collection and Shipment

Sampling Site _____ Date of Collection November 04, 1991Date Samples Received at DataChem November 07, 1991

Analysis

Method of Analysis GC/FIDDate(s) of Analysis November 10, 1991 - November 13, 1991

Analytical Results

Field Sample Number	DataChem Lab Number	Sample Type	Trichloroethylene mg/sample								
5A-110491-P	CL 26482	CT	ND*								
5B-110491-P	CL 26483	CT	ND*								
5C-110491-P	CL 26484	CT	ND*								
6A-110491-P	CL 26485	CT	ND*								
6B-110491-P	CL 26486	CT	ND*								
6C-110491-P	CL 26487	CT	ND*								
7A-110491-P	CL 26488	CT	ND*								
7B-110491-P	CL 26489	CT	ND*								
7C-110491-P	CL 26490	CT	ND*								
8A-110491-P	CL 26491	CT	ND*								
8B-110491-P	CL 26492	CT	ND*								
8C-110491-P	CL 26493	CT	ND*								
VES4-110491P	CL 26494	CT	0.08								

* See comment on last page.
ND Parameter not detected.
NR Parameter not requested.

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() Parameter between LOD and LOQ.

[Signature]
Analyst: Amy Jo Jensen

[Signature]
Reviewer: Pamela Johnson

[Signature]
Laboratory Supervisor: Daniel J. Bruch

960 West LeVoy Drive / Salt Lake City, Utah 84123-2547 / (801) 266-7700
A Sorenson Company

DataChem Laboratories

Quality Control Data Sheet


Batch ID 1991-6084

Analyte Name Trichloroethylene
 Analyst Name JENSEN_A
 Analyst Number 5351
 Method GC/FID
 Results in mg/sample

Matrix Instrument
 Date

14-NOV-1991 14:57

Sample #	Values	Mean	Range	Target	Range/Mean	Status
BLANK	2	-0.0012 Below Range				
CL 26482A	2	-0.0012 Below Range				
CL 26488A	2	-0.0012 Below Range				
QC40579	2	0.0029 Below Range	0.2750	0.0004	0.0013	I I
QC40583	2	0.2791 0.5390 0.5404	0.5490	0.0014	0.0027	I I

16/2/11


by: 

Limit of detection: ~~7.3300E-01~~

0.01 mg/sample



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Date 11/19/91Agency Identification Number 91-3549Account No. 03019

Woodward-Clyde Consultants
4582 South Ulster Street Parkway
Stanford Place 3, Suite 1000
Denver, CO 80237
Attention: Rich Scheig

FAX _____
Telephone (303) 694-2770

Sampling Collection and Shipment

Sampling Site _____ Date of Collection November 11, 1991Date Samples Received at DataChem November 12, 1991

Analysis

Method of Analysis NIOSH 1022Date(s) of Analysis November 16, 1991 - November 17, 1991

Analytical Results

Field Sample Number	DataChem Lab Number	Sample Type	Trichloroethylene mg/sample							
5A-111191-P	CL 27241	CT	ND*							
5B-111191-P	CL 27242	CT	ND*							
5C-111191-P	CL 27243	CT	ND*							
6A-111191-P	CL 27244	CT	ND*							
6B-111191-P	CL 27245	CT	ND*							
6C-111191-P	CL 27246	CT	ND*							
7A-111191-P	CL 27247	CT	ND*							
7B-111191-P	CL 27248	CT	ND*							
7C-111191-P	CL 27249	CT	ND*							
8A-111191-P	CL 27250	CT	ND*							
8B-111191-P	CL 27251	CT	ND*							
8C-111191-P	CL 27252	CT	ND*							
VES4-111191P	CL 27253	CT	0.08							

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Analyst: Lawrence E. MillerReviewer: Don Bruch

Laboratory Supervisor:

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Date 11/27/91Agency Identification Number 91-3603Account No. 03019

Woodward-Clyde Consultants
4582 South Ulster Street Parkway
Stanford Place 3, Suite 1000
Denver, CO 80237
Attention: Rich Scheig

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Telephone (303) 694-2770

Sampling Collection and Shipment

Sampling Site _____ Date of Collection November 18, 1991Date Samples Received at DataChem November 20, 1991

Analysis

Method of Analysis NIOSH 1022Date(s) of Analysis November 22, 1991

Analytical Results

Field Sample Number	DataChem Lab Number	Sample Type	Trichloroethylene mg/sample							
5A-111891-P	CL 27607	CT	ND*							
5B-111891-P	CL 27608	CT	ND*							
5C-111891-P	CL 27609	CT	ND*							
6A-111891-P	CL 27610	CT	ND*							
6B-111891-P	CL 27611	CT	ND*							
6C-111891-P	CL 27612	CT	ND*							
7A-111891-P	CL 27613	CT	ND*							
7B-111891-P	CL 27614	CT	ND*							
7C-111891-P	CL 27615	CT	ND*							
8A-111891-P	CL 27616	CT	ND*							
8B-111891-P	CL 27617	CT	ND*							
8C-111891-P	CL 27618	CT	ND*							
VES4-111891P	CL 27619	CT	0.07							

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Paul C. Gillespie
Analyst: Paul C. Gillespie

Ran Bruch
Reviewer:

Ran Bruch
Laboratory Supervisor:

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DEC 13 1991

Date 12/11/91Agency Identification Number 91-3713Account No. 03019

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Stanford Place 3, Suite 1000
Denver, CO 80237
Attention: Rich Scheig

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Sampling Collection and Shipment

Sampling Site _____ Date of Collection December 02, 1991Date Samples Received at DataChem December 04, 1991

Analysis

Method of Analysis NIOSH 1022Date(s) of Analysis December 06, 1991

Analytical Results

Field Sample Number	DataChem Lab Number	Sample Type	Trichloroethylene MG/SAMPLE GC/FID						
5A-120291-P	CL 28419	CT	ND*						
5B-120291-P	CL 28420	CT	ND*						
5C-120291-P	CL 28421	CT	ND*						
6A-120291-P	CL 28422	CT	ND*						
6B-120291-P	CL 28423	CT	ND*						
6C-120291-P	CL 28424	CT	ND*						
7A-120291-P	CL 28425	CT	ND*						
7B-120291-P	CL 28426	CT	ND*						
7C-120291-P	CL 28427	CT	0.06						
8A-120291-P	CL 28428	CT	ND*						
8B-120291-P	CL 28429	CT	0.01						
8C-120291-P	CL 28430	CT	0.08						
DIS-120291-P	CL 28431	CT	ND*						

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F. Rejali
Analyst: Fred M. Rejali

Jeff R. Scott
Reviewer: Jeff R. Scott

Daniel J. Bruch
Laboratory Supervisor: Daniel J. Bruch

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Date 12/16/91Agency Identification Number 91-3757Account No. 03019

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Attention: Rich Scheig

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Sampling Collection and Shipment

Sampling Site _____ Date of Collection December 09, 1991Date Samples Received at DataChem December 10, 1991

Analysis

Method of Analysis NIOSH 1022Date(s) of Analysis December 14, 1991

Analytical Results

Field Sample Number	DataChem Lab Number	Sample Type	Trichloroethylene mg/sample GC/FID							
5A-120991-P	CL 28834	CT	ND*							
5B-120991-P	CL 28835	CT	ND*							
5C-120991-P	CL 28836	CT	ND*							
6A-120991-P	CL 28837	CT	ND*							
6B-120991-P	CL 28838	CT	ND*							
6C-120991-P	CL 28839	CT	ND*							
7A-120991-P	CL 28840	CT	ND*							
7B-120991-P	CL 28841	CT	ND*							
7C-120991-P	CL 28842	CT	0.03							
8A-120991-P	CL 28843	CT	ND*							
8B-120991-P	CL 28844	CT	ND*							
8C-120991-P	CL 28845	CT	0.02							
VES4-120991P	CL 28846	CT	0.05							

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Analyst: F. RejaliReviewer: Jeff R. ScottLaboratory Supervisor: Daniel J. Bruch



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Date 12/23/91Agency Identification Number 91-3871Account No. 03019

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Attention: Rich Scheig

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Sampling Collection and Shipment

Sampling Site _____ Date of Collection December 10, 1991Date Samples Received at DataChem December 17, 1991

Analysis

Method of Analysis NIOSH 1022Date(s) of Analysis December 21, 1991

Analytical Results

Field Sample Number	DataChem Lab Number	Sample Type	Trichloroethylene MG/SAMPLE GC/FID								
1S-121091-P	CL 30189	CT	ND*								
1M-121091-P	CL 30190	CT	0.39								
1D-121091-P	CL 30191	CT	0.66								
2S-121091-P	CL 30192	CT	0.42								
2M-121091-P	CL 30193	CT	0.01								
2D-121091-P	CL 30194	CT	1.1								
3S-121091-P	CL 30195	CT	0.11								
3M-121091-P	CL 30196	CT	0.48								
3D-121091-P	CL 30197	CT	1.2								
4S-121091-P	CL 30198	CT	ND*								
4M-121091-P	CL 30199	CT	0.32								
4D-121091-P	CL 30200	CT	0.03								
5S-121291-P	CL 30201	CT	ND*								

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Analyst: F. Rejali
Fred M. RejaliReviewer: Jeff R. Scott
Jeff R. ScottLaboratory Supervisor: Daniel J. Bruch
Daniel J. Bruch

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Date 12/23/91Agency Identification Number 91-3860Account No. 03019

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Attention: Rich Scheig

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Sampling Collection and Shipment

Sampling Site _____ Date of Collection December 16, 1991Date Samples Received at DataChem December 17, 1991

Analysis

Method of Analysis NIOSH 1022Date(s) of Analysis December 20, 1991 - December 21, 1991

Analytical Results

Field Sample Number	DataChem Lab Number	Sample Type	Trichloroethylene MG/SAMPLE GC/FID								
5A-121691-P	CL 30124	CT	ND*								
5B-121691-P	CL 30125	CT	ND*								
5C-121691-P	CL 30126	CT	ND*								
6A-121691-P	CL 30127	CT	ND*								
6B-121691-P	CL 30128	CT	ND*								
6C-121691-P	CL 30129	CT	ND*								
7A-121691-P	CL 30130	CT	ND*								
7B-121691-P	CL 30131	CT	ND*								
7C-121691-P	CL 30132	CT	0.01								
8A-121691-P	CL 30133	CT	ND*								
8B-121691-P	CL 30134	CT	ND*								
8C-121691-P	CL 30135	CT	0.02								
VES4-121691F	CL 30136	CT	0.08								

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Analyst: F. Rejali
Fred M. RejaliReviewer: Jeff R. Scott
Jeff R. ScottLaboratory Supervisor: Daniel J. Bruch
Daniel J. Bruch

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